POWER

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Getting at the Heart of It

I KNEW a man who had a mill. And because he made things that people wanted and made them as they wanted them, his business grew and grew.

And finally it got so large that the engine would not carry it.

But when he went to get a new engine, he was told that his present engine was large enough to drive more machinery than he had.

They sent a man to look at it, and he found that when the load got to a certain point the engine began to slow down; so he changed the springs in the governor.

And still the engine ran beautifully up to a certain load, but when any more load was put on she slowed down.

Then another man came from the shop and took indicator diagrams and made adjustments; but while the load was still below the capacity of an engine of that size, speed and pressure, she would lie down.

And the orders piled up, and the mill could not turn them out for lack of power.

Finally, the owner in desperation went to an old engineman friend and said that, much as he hated to do it, he was going to shut down Saturday noon and stay shut down until the engine was fixed, and wanted his friend to come over and fix it.

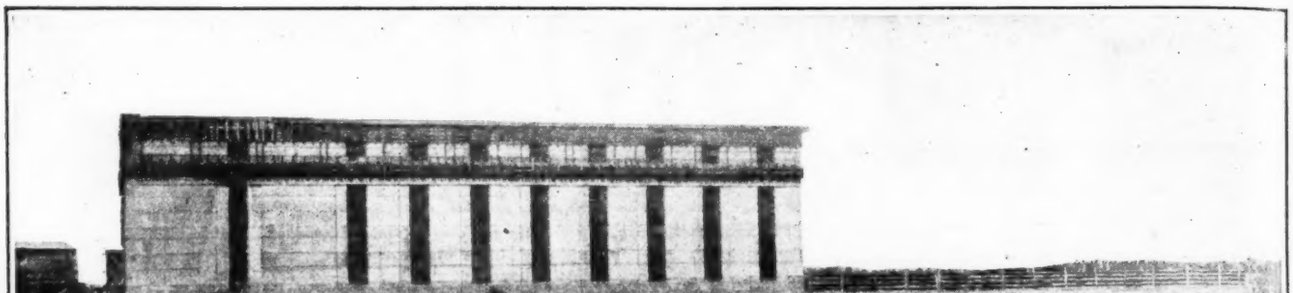
The friend agreed, but when he was asked when the help should be told to come back, he said, "Don't let them go at all until we find out what is the matter."

The engineman went over Saturday afternoon. He soon found that the governor would not swing out so as to allow the valve to cut off much more than quarter-stroke. It did not take him long to find that the reason it would not swing out was that it hit upon a pin. It took only a few minutes to drive the pin back where it belonged.

And the mill did not have to shut down, and the engine handled all the load they had to give it.

Simply because there was a man who knew how to go to the heart of things instead of looking wise and doing a lot of guessing and poking around in the dark.

F. R. Low



Power house of concrete and structural-steel construction and built into dam

Great Falls Hydro-Electric Development of the Manitoba Power Company

SITUATED just north of the international boundary line, about midway between the Atlantic and the Pacific Oceans, is the Province of Manitoba, Canada. Since the great coal deposits of Canada are in Nova Scotia on the east coast and in British Columbia on the west, Manitoba must depend on the United States for coal or utilize the lignites that are found in the Canadian middle west. Although there are small lignite deposits in the southern part of the province, they have not been developed to any appreciable extent and practically all coal is imported. There appears to be no oil or natural gas in commercial quantities, and the geological formations are not considered favorable for such deposits. These conditions make water power, with which Manitoba has been richly endowed, of first importance in the future industrial development of the province.

Just as the Mississippi River and its tributaries form the great central drainage system of the United States, so do the Winnipeg and Nelson Rivers form the great central drainage system of Canada. The two are connected by Lake Winnipeg and flow into that great inland sea, Hudson Bay. The Winnipeg River lies almost entirely within the Province of Manitoba and for natural water-storage advantages is probably unequaled on the American continents. It drains an almost circular area of 53,000 miles, 11,000 square miles of which is in the State of Minnesota, 37,900 in the Province of Ontario and 4,600 in Manitoba. Dotted in all directions at the head of the Winnipeg River are 110 lakes ranging in size from 2 to 1,500 square miles, the largest being Lake of the Woods. Looking at Fig. 1, it will be seen that the Winnipeg River forms the connecting link between Lake of the Woods and Lake Winnipeg. Leaving Lake of the Woods, the river flows in a northwesterly direction, widening into deep lake-like expanses, with little or no current and again narrowing into channels and forming rapids. This characteristic formation continues through the entire length of the river, a distance of 150 miles between the two lakes.

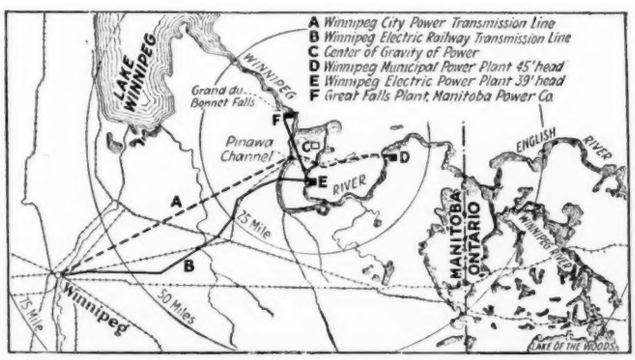


Fig. 1—Location of existing plants on Winnipeg River

These lake-like expanses along the river's course are available for large storage reservoirs at the various power sites to assist in equalizing the flow of the river. In the distance between the two lakes there is a drop of 347 ft. divided into a series of falls. Fig. 3 shows the location of the different falls and the power sites. Of this total fall about 275 ft. is on

COMPLETE project will consist of a dam nearly a mile long and the installation of six 28,000-hp. turbines to operate under a 56-ft. head, and each will require 5,200 cu.ft.-sec. of water at full load. The turbines are of the propeller type and are the largest capacity of this type ever constructed. Two are installed in the initial installation and have operated for over a year under heads varying from 18 to 50 ft. dur- the completion of the dam. Special features are incorporated in the design of draft tubes and scroll cases.

the river within Manitoba which, with a minimum regulated flow of 20,000 cu.ft.-sec., is estimated to produce 418,000 hp. continuously. The total precipitation within the drainage area of the river over a period of years has been sufficient to give 25,000 cu.ft.-sec. continuous flow, from which could be produced over 500,000 continuous horsepower, all of which is within 50 to 90 miles of Winnipeg City, a rapidly growing metropolis of about 200,000 population.

Realizing the importance of water-power resources to the future development of Manitoba, the Canadian government in 1911 began a survey of the Winnipeg River basin with the object of insuring the maximum utilization of the power resources of the river within the Province of Manitoba. This survey was completed in 1915 and has provided for utilizing the 18 falls in the river at seven sites. This is to be done by building dams at the highest falls to flood out the small drops or by cutting channels in the river bed to lower the tailwater level to that of the headwater level of the site below. This survey not only decided upon the proposed power sites and methods controlling the flow of the river, but also worked out the tentative design of the dam and power station that should be constructed at each site.

It is at the du Bonnet Falls site, the highest head (56 ft.) on the river, that the Manitoba Power Co. is constructing what is known as its Great Falls plant. This site includes three falls: Whitemud, 12 ft.; Little du Bonnet, 9 ft.; and Grand du Bonnet, 35 ft. By constructing a dam at Little du Bonnet Falls it was possible to flood out the 9- and 35-ft. falls and raise the headwater level to that of the tailwater level of the proposed site above. Whitemud Falls is about 3 miles below Little du Bonnet Falls and is formed by a granite ridge about 1,800 ft. long across a deep basin between the two falls. By cutting a channel 200 ft. wide and 20 ft. deep in this ridge, the water level back to the power site will be lowered about 10 ft., making a total operating head of 56 ft. This channel is considered large enough to handle the flood water of the river without materially affecting the tailwater level at the plant.

The proposal of the government engineers was to construct the dam at Little du Bonnet Falls, but

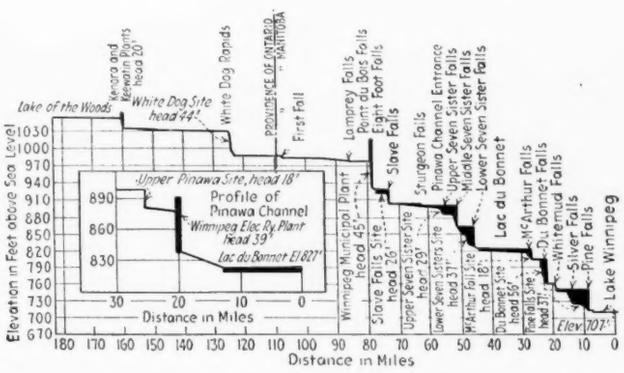


Fig. 3—Profile of Winnipeg River, showing existing plants and proposed sites

investigation by the power companies' engineers led to a decision to construct the dam and power house below the falls at what is known as Island No. 2. The dam, when completed, will be of a height to raise the original water level 46 ft., and by lowering the original water level below the dam 10 ft. a total head of 56 ft. will be obtained for which head the turbines are designed. Since the island divided the river into two channels, it was possible to close the west channels by a cofferdam and pass all the water through the east channel, while

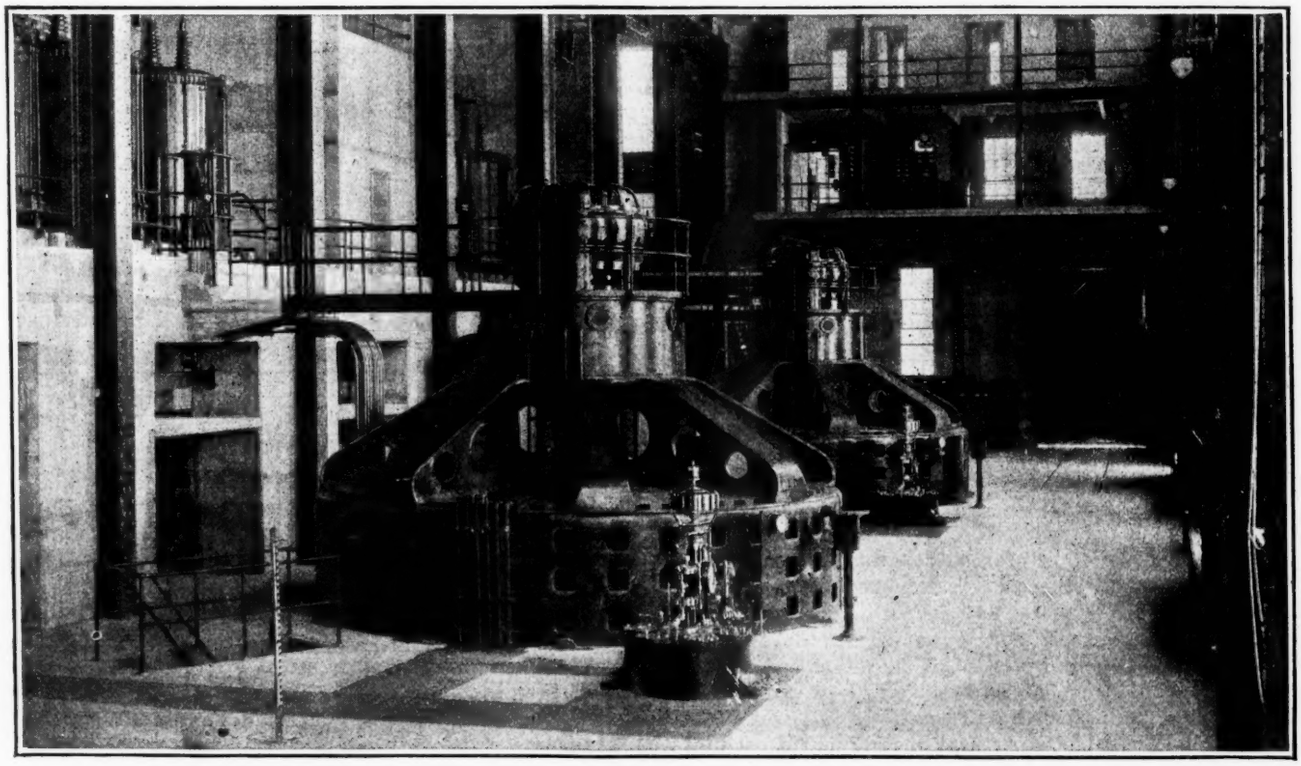


Fig. 2—Each 21,000-kw. generator is connected directly to a bank of 11,000- to 66,000-volt transformers

the gates and wheel-pit openings in the power house were being constructed in the former. When this work was completed, all the water was passed through these openings while the dam was constructed in the east channel.

The general arrangement of the dam and the location of the power house are shown in Fig. 4. Beginning at

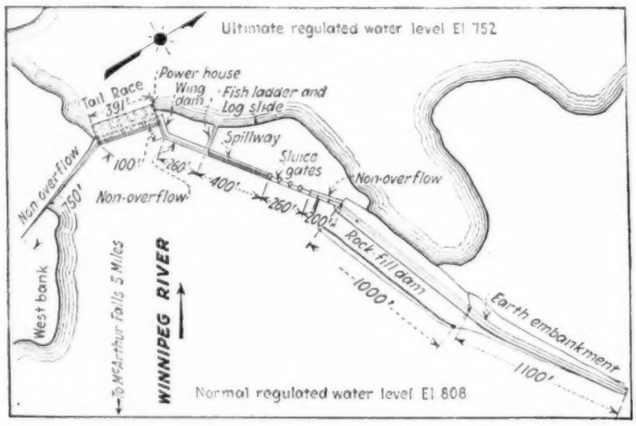


Fig. 4—General arrangement of dam and power house

the west bank of the river, the first section of the dam, which extends from the shore to the power house, is approximately 750 ft. long, is of the non-overflow type, is of solid concrete and has a maximum depth of 70 ft. with its crest elevation at 816. The next 391 ft. of the dam comprises the power house, from the east end of which a concrete wing dam extends 100 ft. upstream and includes a skimming weir over which is discharged ice and other floating material deflected from the power station by a curtain wall which extends 8 ft. below normal water level. From the end of the wing dam the next 260 ft. is the same as the section extending from the power house to the west bank. From this point a 400-ft. spillway is constructed with a crest elevation at 808, and will be provided with flashboards to raise the elevation to 810. At the east end of the spillway there are four steel sluice gates. These gates, which are on the crest of the island, are 30 ft. high by 50 ft. wide and are designed to pass the maximum flow of the river. For 200 ft. east of the sluice gates the dam is of the non-overflow concrete type with elevation at 816. Across the east channel the dam for 1,000 ft. is of the rock-fill type, and on the east bank the dam will be an earth embankment 1,100 ft. long with a concrete core wall. This gives a total length of dam and power house of nearly 4,500 ft. This dam, when finished, will raise the present water level 46 ft. and will form a storage reservoir extending up river for about five miles, which will have an area of about 3 square miles.

The power-house foundation water passages and turbine settings are of reinforced concrete, and the building proper is of structural steel and concrete. The plant is 110 ft. wide by 391 ft. long, and when completed, which it is planned to do within the next five years, it will contain six 28,000-hp. vertical-shaft turbines of the propeller type, set on 57-ft. centers. In the initial installation the foundations and water passages will be completed so that installing future units will not require any unwatering. The power house will be completed to house three units although only two are being installed at present. Under full load and a head of 56 ft. each turbine will require about 5,200 cu.ft.-sec. of water. The gate openings to the scroll case are 14 ft. wide and are divided into three sections by two equally spaced piers 4 ft. thick. Between the intakes for each turbine are concrete piers 7 ft. thick designed to stand a head of 60 ft. A velocity of 4.5 ft. per sec. will be obtained through the passages with full load on the units. In the piers checks are provided for gates, stop logs and racks. The stop logs are provided to facilitate inspection and maintenance of the steel gates, which are of the Stoney type and motor operated. Screens consisting of heavy steel bars spaced 4-in. centers supported on a steel framework, are designed to withstand the full head should these racks for any reason become clogged. A 30-ton traveling crane is provided in the gate-and-screen house for handling the screens and gates.

In the west end of the station there are two sluiceways provided to take care of the flood water in the winter when the gates are frozen in the spillway. These sluiceways are 13x24 ft. at their intake end and 10x15 ft. at their outlet. This design results in a gradual acceleration of the water and prevents local vacuums or eddies forming within the sluiceway. It is expected that this construction will prevent any floating logs that might happen to be in the tailrace from entering the sluiceways when their gates are open, which has

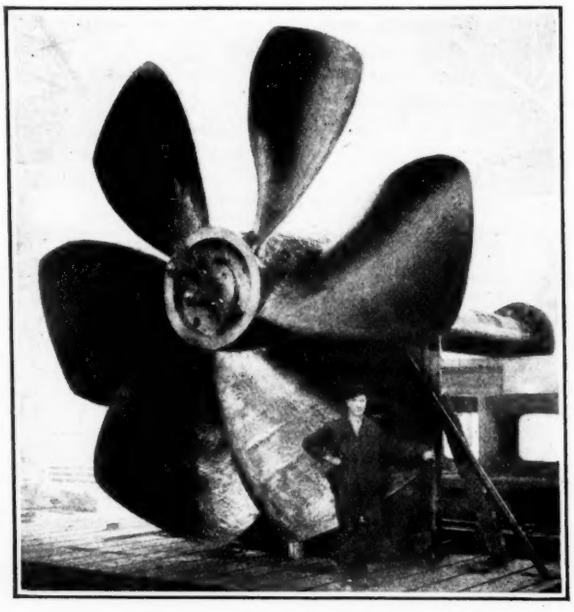
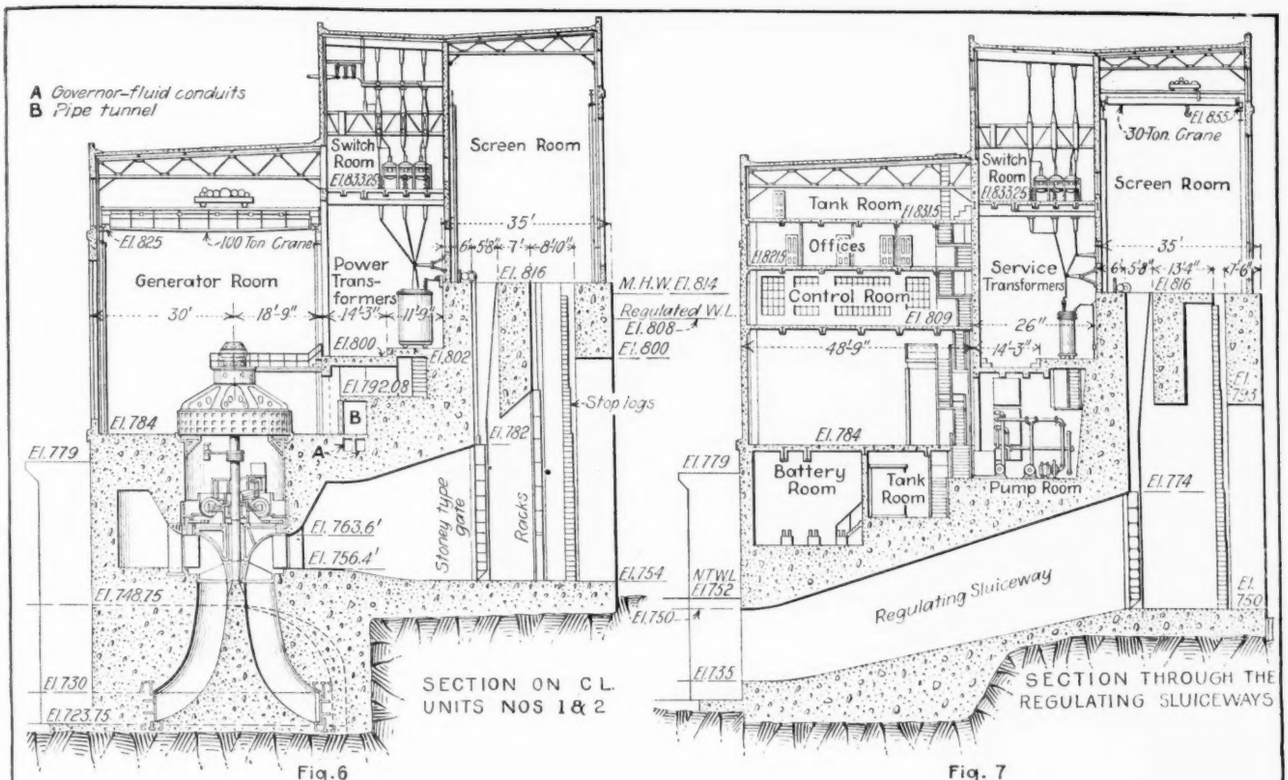


Fig. 5—Runner is rated at 28,000 hp. and is 15 ft. 9½ in. in diameter

been known to happen when the water passages have been constructed with an increasing section. The entrance to the sluiceways is closed by Stoney type motor-operated gates.

The draft tubes, which are of the Moody spreading type and are 54 ft. maximum diameter, offered a structural problem of first importance. Furthermore, in this installation the unit spacing is somewhat restricted so that the depth of the draft tube and surrounding water passages is greater in proportion. The usual way of supporting the draft tube is from the reinforced-con-



Figs. 6 to 8—Elevations and plan of present power house

Each draft-tube bell is supported on eight equally spaced cast-iron columns under its lower end. These columns are similar in form to the stay vanes in the scroll case, and are placed so as to assist in turning the outflowing water toward the tailrace. To prevent the tendency for the formation of a central vacuum, which would cause upward eddies in the central portion of the draft tube, the center cone in the tube has been extended up to an elevation just below the runner. No cast-steel speed ring is used in the scroll case, the ends of the stay vanes being cast into the concrete forming the scroll. The two regulating sluiceways have been designed with a decreasing cross-section in the direction of the water's flow.

crete slab under the turbine, which means that the total weight of the complete unit and draft tube must be transmitted to the piers beyond the tube. This type of construction would have resulted in concrete work strong enough to support loads of many thousand pounds to the square foot. In the Great Falls installation the lower end of each draft-tube bell is supported on eight equally spaced cast-iron columns, similar to

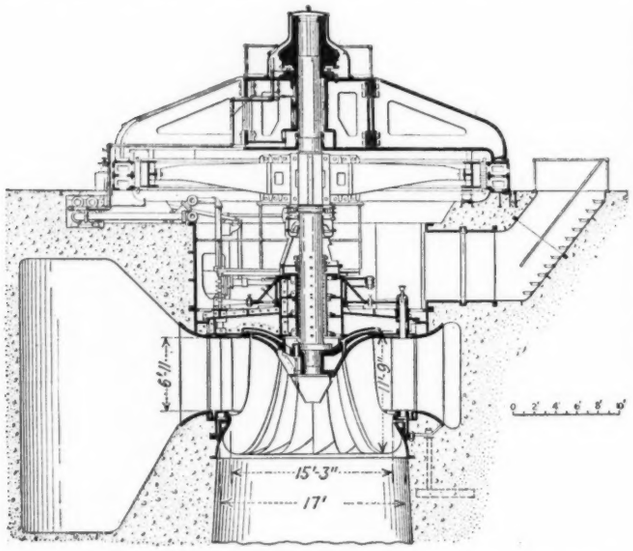


Fig. 9—Cedars units rated at 11,300 hp. at 55.6 r.p.m. under 30-ft. head

the cast-steel stay vanes in the scroll-case speed ring and are cast into the concrete (see Figs. 6 and 10).

The vanes are so shaped as to assist in turning the outflowing water toward the tailrace. They are designed to support the total superimposed weight of the turbine, generator, concrete and water in the casing. This arrangement has resulted in simplifying the construction of this type of tube to where it is comparable to a bent tube. It has also greatly reduced the amount of reinforcing and concrete necessary in the foundation with a corresponding reduction in construction cost. To prevent the tendency for the formation of a central vacuum, which would cause upward eddies in the central portions of the tube with loss in efficiency, the center cone in the tube has been extended up to an elevation just below the runner, Figs. 6 and 10. The shape of this cone conforms to the natural flow of the water as determined by the inner surface of the tube. The top end of the cone is provided with a cast-iron cap that extends through the lower end of the runner cap and will form a pedestal to support the turbine runner and shaft when erecting or dismantling the unit. The importance of efficient draft-tube design in low-head plants is emphasized by the fact that in this installation approximately 30 per cent of the total energy in the water due to the static head of the plant is in the velocity head of the discharge from the turbine runner.

A concrete scroll case with cast-steel stay vanes set in the concrete form the setting for the turbines. At the upper end, the stay vanes are provided with lugs for supporting the cast-iron pit liner before pouring the concrete. Instead of using a speed ring with integral cast stay vanes, as is usual practice in concrete scroll cases, in this installation the stay vanes are made separate. The vanes are built in with the forms for the concrete and are securely anchored with long foundation bolts (see Fig. 10). This is a new type of construction and results in a considerable saving in material and machine-shop work. However, on account of the greater erection cost this method of construction will probably be applicable only to large units.

Among the most interesting features of the installation are the turbine runners which are of the high-speed propeller type and are the largest capacity wheels of this type that have ever been constructed. Since the Francis-type runners of the turbine installed in the Cedars plant of the Montreal Light, Heat & Power Consolidated are about the same diameter as those installed at Great Falls, a comparison will be of interest. The Cedars runners operate under a normal head of 30 ft., run at 55.6 r.p.m. and develop 11,300 hp. each. These runners have a throat diameter of 15 ft. 3 in., are 11 ft. 9 in. high and weigh 175,000 lb. The total weight of the turbine, not including the governor or pumping system, is approximately 1,000,000 lb. They are set in a concrete scroll case, Fig. 9, with a cast-iron speed ring and discharge into a bent draft tube. The

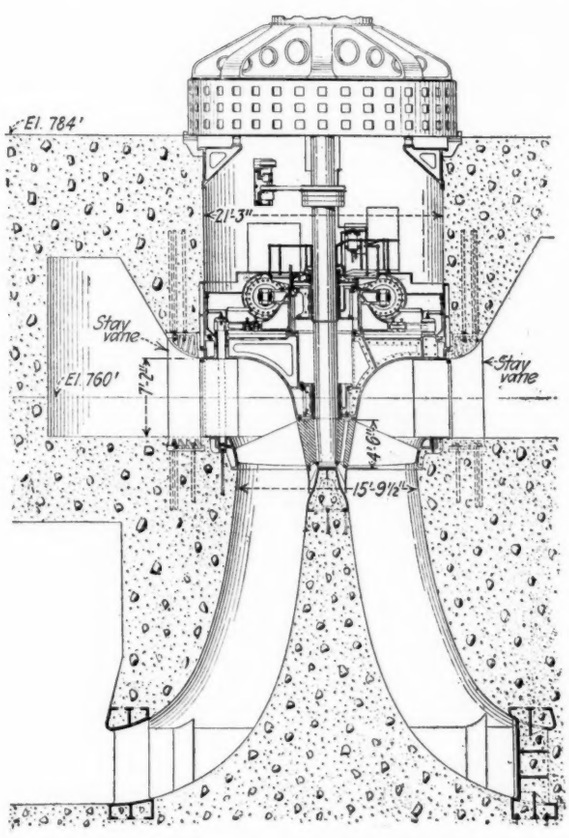


Fig. 10—Great Falls units rated at 28,000 hp. at 138.5 r.p.m. under 56-ft. head

speed ring stays together the concrete above and below the spiral casing and takes the downward thrust of the generator and surrounding concrete. In this installation the turbine head cover is bolted to the speed ring. On account of the slow speed of the units the generators are of very large dimensions, being 37 ft. 4 in. outside diameter.

At Great Falls the turbines operate under a 56-ft. head, run at 138.5 r.p.m. and develop 28,000 hp. each.

The runners have a throat diameter of 15 ft. 9½ in., which is 6½ in. larger than the Cedars runners, but are only 4 ft. 6 in. high as compared to 11 ft. 9 in. for the Cedars machines (see Fig. 10). The Great Falls runners are cast in one piece and weigh about 72,000 lb. If the Cedars turbines as they are now designed were operated under 56-ft. head, they would develop 28,800 hp., which is approximately the capacity of the Great Falls units, so that the foregoing gives a fair comparison of the dimensions of the two types of runners used under the same conditions. The Cedars units, however, under 56-ft. head would run at a speed of only 76 r.p.m. as compared with 138.5 r.p.m. for the new units. Thus the propeller-type units are over 80 per cent higher in speed than the Cedars units, which were considered to be of exceptionally high speed at the time they were built.

A comparison of Figs. 9 and 10 will show that the chamber between the turbine guide vanes and runner is much larger in the Great Falls units than in the Cedars. Another feature is the wide space between the blades on the wheel as indicated in Fig. 5, which results in little danger of clogging from ice and débris. These runners have unusually large blade areas compared with some of the designs of propeller-type runners in use and avoid any extreme hydraulic conditions. The peripheral speed of the runners is high, being about

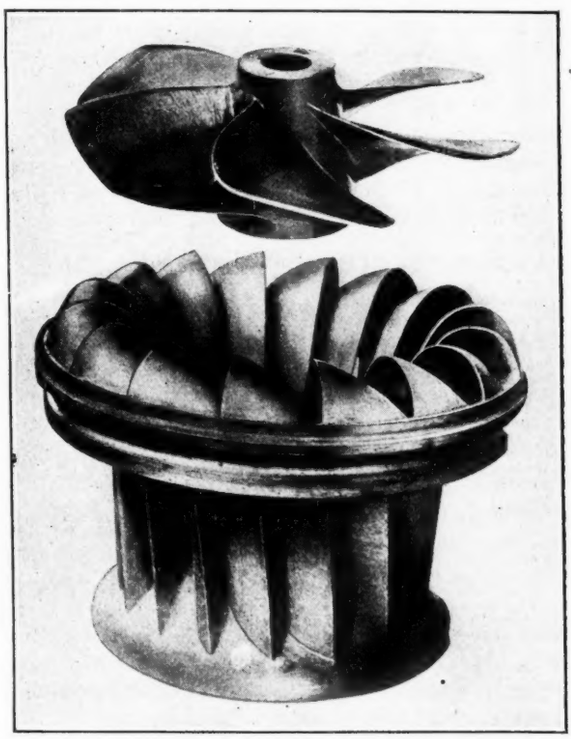


Fig. 11—Comparison between the Cedars and Great Falls runners

If the Cedars runners were operated under the same head as the Great Falls runners, they would develop 28,800 hp. and run 76 r.p.m., where the new type runners develop 28,000 hp. at 138.5 revolutions per minute.

twice the spouting velocity of the water under a 56-ft. head, or 7,000 ft. per min. On account of their large size, the cover plates for the turbines are cast in two parts. The lower surface of these plates is cone-shaped, Fig. 10, to conform to the flow lines of the water, and the upper surface is arranged to support the lignum-vitæ guide bearing for the mainshaft.

Instead of being supported on the speed ring, as is general practice, the cover plate is bolted to the cast-iron pit liner. The guide vanes are made of cast steel and are fitted with separate stems which are supported in bronze-bushed bearings in the head cover and distributor plate. These guide vanes are the largest that have ever been constructed, being 7 ft. 13¼ in. high by

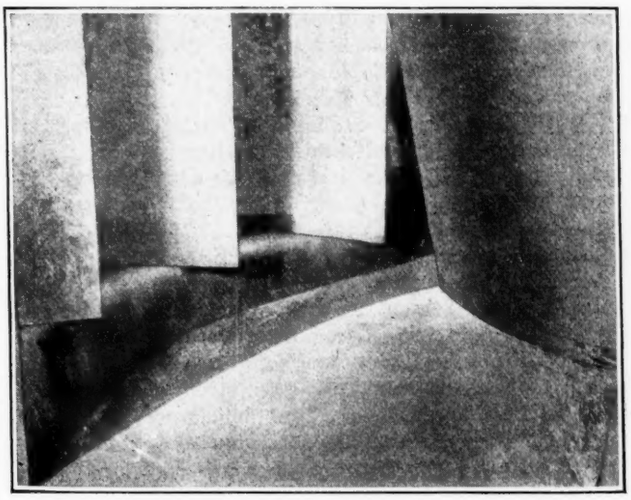


Fig. 12—View inside one of the Great Falls turbines

In the foreground the runner can be seen; on the left the lower end of three guide vanes; and on the right the cone on the lower side of the cover plate.

4 ft. 7 in. wide. To protect the guide vanes against being overstressed should obstructions become lodged between them, they are connected to the operating ring by double-acting shearing links.

An important feature of the propeller-type runner is its ability to operate under greatly reduced heads, which, in the case of the Great Falls plant, made it possible to start operation over a year ahead of the time service could be rendered with Francis-type wheels. When the rock-fill section of the dam is completed, it will raise the headwater about 25 ft., and the cutting of the channel through the rock reef about three miles below the plant will lower the tailwater about 10 ft., or an increase of head on the plant of about 35 ft. However, the plant will be in operation over a year before this work is completed and will operate under heads varying from 18 to 50 ft. Each turbine under this condition will develop about 7,500 to 25,000 hp. at normal speed. It was expected that the runners might corrode some when operating under the low head, but even if they should do so to an extent that would require their renewal, the income from the plant will much more than cover this cost.

On account of these propeller-type runners representing a radical departure from previous practice, some engineers have naturally been skeptical, particularly with reference to vibration troubles and pitting of the runners. In this connection these turbines operate quietly under the overspeeded condition resulting from the low head. One runner has been examined after about six-months' operation and found to be in good condition, the paint still being intact on most of the surfaces. Based on recent power tests of these turbines under a head of 47.5 ft., each unit developed about 24,000 hp. at normal speed.

When operating under a 23-ft. head, the turbines develop a specific speed of 230 (ft.-lb. system) as com-

pared with 153 under normal head of 56 ft. When one of the turbines was first started under an effective head of 17 to 20 ft., a gate opening of about 25 per cent was required to overcome the friction of the bearing surfaces. However, after being put into operation it was found that the machine could be started with from 3 to 9 per cent gate opening. When this plant is operating under normal head conditions, the tailwater elevation will be about three feet below the bottom of the runner. This low elevation of the turbine is a safeguard against unstable hydraulic conditions in the draft tube.

Figures are not yet available as to the efficiency of the units under normal conditions, but a 16-in. model tested in the I. P. Morris laboratory developed an efficiency of 85 per cent and a 35-in. homologous model of the turbine and draft tube tested at Holyoke showed a maximum efficiency of 88.5 per cent.

A central pumping system is used with accumulator tanks at each machine for the governors. A bypass is provided so that a certain amount of water at all times is discharged into a cylinder tank connected with the sump tank. This allows constant circulation of the water through the pumps at all times which prevents their overheating when operated continuously, and the pressure variation is considerably less than when the bypass is not used. The governor-pressure piping is run in a gallery *B* on the generator-room floor and the water returns by two conduits *A*, Fig. 6, formed in the concrete under this gallery.

Each turbine is connected to a 21,000-kw. three-phase 60-cycle 11,000-volt alternator. These machines have a guaranteed efficiency of 97.1 per cent. Excitation is supplied by a direct-connected 150-kw. exciter on each machine, mounted above the thrust bearing. The entire weight of the revolving element is carried on a Kingsbury-type thrust bearing supported on the generator's stator frame. This bearing is designed for a load of 950,000 lb. at the rated speed of the machine and is provided with water-cooling coils.

The 11,000-volt leads of each generator go directly to a 21,000-kva. bank of transformers consisting of three single-phase 11,000- to 66,000-volt units connected delta to delta. There are no switches between the generator and transformers. The guaranteed full-load efficiency of the transformers is 98.8 per cent. Provisions have been made to facilitate the handling of the transformers by mounting them on trucks in their bays from where they can be run onto a transport car on a track that runs the full length of the plant. On this track the transformers can be easily moved to near the west end of the station, where they are moved from the car onto another track running out under the crane in the generator room. The high-voltage leads of the transformers connect through an automatic oil switch to the high-tension busbars from where the power is transmitted to the City of Winnipeg, 75 miles away.

Including turbines, generators, exciters, thrust bearings, transformers and switches, the cost for the equipment is less than $14 per hp. For the present installation of two units including all permanent works for the complete development a cost of less than $80 per hp. is obtained, and for the completed installation of six units it is expected the cost will be less than $60 per hp.

The author wishes to acknowledge with thanks the assistance rendered in the preparation of this article by F. H. Martin, chief engineer, Manitoba Power Co., Ltd.; H. S. Van Patter, assistant hydraulic engineer, Dominion Engineering Works, Ltd.; S. Svenningson, chief engineer, Shawinigan Engineering Co., Montreal, Canada; and H. Birchard Taylor, vice-president, William Cramp & Sons Ship & Engine Building Company.

TABLE OF IMPORTANT DATA OF THE GREAT FALLS PLANT OF THE MANITOBA POWER COMPANY

Location of plant	Great Falls, Manitoba
General layout of development and detail design of power house	Shawinigan Eng. Co., Ltd.
Detail design of structures exclusive of power house	Manitoba Power Co., Ltd.
Constructed by	Fraser Brace, Northern Construction Co.
Present capacity, hp	56,000
Ultimate capacity, hp	168,000
Size of units, hp	28,000
Width of power house, outside, ft	110
Width of generator room, inside, ft	48
Width of transformer bay, inside, ft	26
Width of gatehouse, inside, ft	30
Length of generator room, outside, ft	301
Length of gatehouse inside, ft	380
Distance from generator-room floor to bottom of roof truss, ft	54
Total concrete in one finished unit, cu.yd	8,600
Full-Load Water Velocities Feet per Second:	
Under curtain wall, at gatehouse	2.7
Through racks	4.0
Through penstocks gates	4.4
At discharge from turbine runner (vertical component)	26.5
Discharge from draft tube to tail race	5

PENSTOCKS AND GATE HOUSE

Curtain wall extends below normal water level, ft	8
Racks, two section high, made of ½-x4-in. iron bars, on edge, spaced 4 in. apart.	
Head Gates at Penstock Mouth:	
Manufacturer	Dominion Bridge Co., Ltd.
Type	Motor operated, Stoney
Size	28 ft. 6 in. x 15 ft. 6 in.
Two head gates in regulating sluiceways, motor-operated Stoney type.	
Penstocks:	
Number per turbine	3
Material	Reinforced concrete
Size of each at entrance	28 x 14 ft.

TURBINES, GOVERNORS AND DRAFT TUBES

Manufacture of turbines	Dominion Engineering Works, Ltd.
Type	Moody, propeller
Number installed, present	2
Number installed, ultimately	6
Size, hp	28,000
Guaranteed, efficiency, per cent	87
Flow, cu.ft. per sec. per unit at full load	5,200
Head, ft	56
Specific speed (ft.lb. system) at normal head of 56 ft.	153
Horsepower under 1 ft. head	66.8
Speed, r.p.m.	138.5
Guide bearing, lignum vitae, water lubricated	
Scroll case, concrete with cast-steel stay vanes cast into the concrete, inside diameter, ft	22
Draft tubes:	
Type	Moody Spreading
Bottom of runner above bottom of draft tube	30 ft. 6 in.
Diameter at runner discharge	15 ft. 10 in.
Maximum width of chamber at bottom, ft	54
Width of bell outside at bottom	38 ft. 3 in.
Bottom of bell from bottom of chamber	6 ft. 6 in.
Length of bell from bottom of runner, ft	24
Height of cone; extends to runner hub; will be used to support rotating element when thrust bearing is being overhauled	
Size of discharge to tailrace, two openings, 25 ft. high x 21 ft. wide	
Governors:	
Manufacturer	Dominion Engineering Works, Ltd.
Type I. P. Morris double floating lever; belt driven from mainshaft	
Location, generator floor	
Governor pumps, number, 3; capacity, 165 gal. per min. each; type, motor-driven rotary	
Governor fluid, water under 185 lb. pressure	
Manufacture of governor pumps	Canadian Ingersoll Rand Co.

MAIN GENERATORS

Manufacturer	Canadian General Electric Co.
Size, 21,000 kva.; voltage, 11,000; phases, 3; frequency, 60 cycles.	
Guaranteed efficiency, per cent	97.1
Number of poles, 52; speed, 138.5 r.p.m.	
Exciter, direct-connected; capacity, 150 kw., 125 volts.	
Thrust bearing, Kingsbury type, mounted on top of generator, designed for 950,000 lb. at 138.5 r.p.m.	

MAIN TRANSFORMERS

Manufacturer	Canadian General Electric Co.
Number installed	6
Type, indoor, oil insulated, water cooled	
Size, 7,000 kva.; Voltage, 11,000 to 63,500/110,000	

MISCELLANEOUS

	Manufacturer
Storage Battery	Electric Storage Battery Co
Pumps	Canadian Ingersoll-Rand Co.
Lubricating Oil Filter	S. F. Bowser & Co., Inc.
Transformer Oil Filters	Canadian General Electric Co.
High-Tension Oil Switches	Canadian Westinghouse Co.
Switchboards	Canadian General Electric Co.
Traveling Cranes	Dominion Bridge Co., Ltd.

The Troubleman Saves a Contract

By H. T. Melling

During the early days of the internal-combustion engine manufacturers' descriptive literature carried the inference that no skilled attendant was required to operate their gas or oil engines. This is correct only in the small-engine class, where occasional shutdowns are not of great importance. From long experience with medium and large internal-combustion engines my contention is that it requires not only a first-class mechanic, but a man that can foresee and ward off operating troubles in time to prevent a shutdown or a serious breakage. This can be obtained only by having a thorough knowledge of this type of engine combined with using one's eye, ear and nose and touch. Training these organs will enable the man in charge to detect quickly anything out of order. It is only by careful attention to all details that any power station can be kept up to its highest efficiency, the internal-combustion engine in this respect differing in no way from a steam engine or boiler.

Operating Procedure

Daily log check should be kept, giving the total hourly load, showing the fuel and lubricating oil used per shift, the circulating-water and lubricating-oil temperatures, together with comments of the shift engineer, so that both the superintendent and the operating engineer will at all times be familiar with the state of the main units and auxiliaries. These reports will greatly assist in checking up what repairs are required and when it will be necessary to shut down any engine for adjustments.

Indicator diagrams, showing the compression pressure in each cylinder, also light-spring suction and full load diagrams, should be taken every week. In addition the mean effective pressure for a given load should be checked from week to week.

The information gained by a thorough system of operating reports combined with the monthly statement of repair costs not only enables the cost of power to be arrived at, but denotes exactly what part requires the most upkeep. The faulty parts can then be put in first-class condition or redesigned to stand up to operating conditions, thereby eliminating further repair charges and shutdowns.

The writer was on one occasion detailed to report on a tandem gas engine driving a dye works, which had not been accepted from the makers. On my arrival at the works I found the engine to be in a bad state. I was informed by the manager in no friendly tone that they intended to have it replaced by another make and that my visit had come too late, for several men from the shop had tried to improve the operation without results.

Since this company had in different parts of the factory three more of our engines, although of older design, which had given good results, I felt that it was up to me to prevent another competitor from replacing our latest engine. Consequently, I explained to the manager that I intended to stay around for a few days.

On examination I found that no logbook was kept and if any stoppage took place or piece of cloth was spoilt in dyeing, it was reported to be caused through the engine, even if this was not the case. I insisted that daily logs should be made of the engine and gas-producer operations, giving in detail the consumption of lubricating oil and any stops or late starting that was accountable to the engine. The operation of this part of the factory had to be continuous night and day during the week with a shutdown from Saturday noon until Monday morning.

The engine was of the tandem single-acting type having water-cooled pistons supplied through telescopic joints on the rear piston. On my first inspection it appeared that these plungers were out of line, for considerable water was being drawn into the rear cylinder. This spoiled the lubrication, which was feeding far too fast, and at times would cause preignition, the flames of the explosions shooting past the rings. The piston-rod packing was also a source of trouble by continually leaking and blowing.

On feeling the plunger rods for the water circulation through the pistons, it was easy to note they were badly worn. An order was thereupon dispatched for a set made up of harder metal. The rear piston being withdrawn, it was found that owing to the lubrication being destroyed by the water from the connection to the piston, the piston rings had worn considerably and new ones had to be installed. After the water-circulation plungers had been fitted and lined up parallel with the cylinder, this completed our first week-end labor.

Monday morning a long delay was caused in starting, which I was informed was a common occurrence. After several trials it was found that the igniters were covered with water and had to be dried out. On inspecting the gas main from the pressure producer, considerable water was found owing to the sumps never having been drawn. The plugs were replaced by valves and the producer operator was ordered to drain these every week, making the proper notations on the log sheet.

Taking Out the Kinks

During the following week I visited the works and went over the design of the piston-rod packing, which was found to be of the standard type but without any fire rings. After considerable persuasion the shop consented to insert two fire rings made in sections so that they could be installed without disconnecting the rod. These two rings took the place of the two front spring rings; this also was a great improvement and the engine was now getting down to good operation. The lubricating oil had been brought to its normal feed as was shown by the daily log sheets.

I had up to this time avoided the manager. However, on his entering the engine room one day, he remarked on the improvement in operation, but expressed himself rather forcibly that the lubricating oil was excessive. On my showing him the actual consumption, he did not cool off but left the engine room rather hurriedly.

In the course of a few days I found out what was troubling him. Our other competitors had been sitting tight on the job, expecting every day that our engine would be thrown out. I had the pleasure of meeting their salesman and having a long talk with him, in which I expressed myself very strongly on their foolishness on trying to get our engine discarded, when all that was wrong was poor attendance.

After standing by the installation for several weeks, I was rewarded by the fact that the insurance company accepted the risk. Returning to the works, I received a nice bonus, which was due to a great extent to introducing daily engine-room reports.

Relation of Pressure and Velocity in Various Types of Steam Turbines

BY FRANCIS P. HODGKINSON

Reaction and impulse types of turbines were explained by Mr. Hodgkinson in the issue of Jan. 29. With these principles in view this article describes the variation in steam pressures and velocity for various types of turbine stages.

THERE is a certain definite ratio of blade velocity to the velocity of entering steam, that will give the best economy in each type of turbine stage. Since we are not taking up in this article the dynamics of the turbine types, we will not go into the factors that determine this ratio. Suffice it to say that

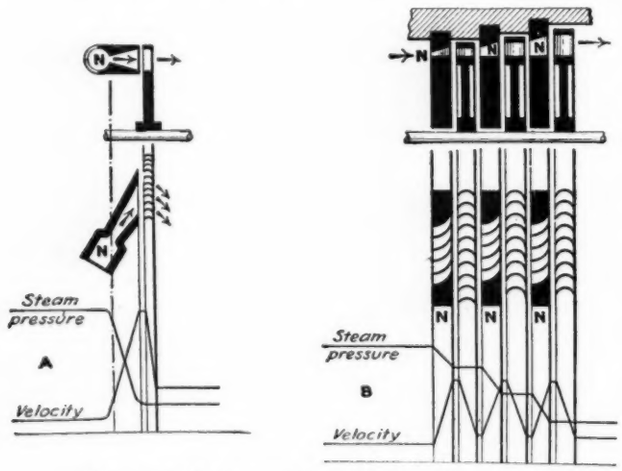


Fig. 1—Single- and multi-pressure stages

The entire pressure drop occurs in a single nozzle at *A*, producing high steam speed, as in the De Laval type stage. The total pressure drop is divided among three nozzles in the multi-stage Rateau type turbine at *B*. The steam has approximately one-quarter of the speed of that at *A*. This allows more moderate blade velocities and a lower rotating speed.

in the impulse type where the steam jet makes an angle of 20 deg. with the plane of the wheel and the blades are of symmetrical form, the ratio is about 47 per cent of the jet velocity. In other words,

$$\frac{\text{mean blade speed}}{\text{speed of entering steam}} = 0.47 \text{ for highest efficiency.}$$

If the full expansion from initial to final pressure takes place in a single set of nozzles, the blade velocity for best economy is usually too great for the structure of the rotor and blades, due to the enormous centrifugal force produced thereby. In addition to this the high rotative speed involved with high blade speeds usually prohibits the direct connection of the driven element to the turbine shaft. If the design is such that the total expansion does take place in a single set of nozzles, it is usually necessary to use lower blade speeds than those giving highest efficiency, and also to use gearing of some kind between the turbine and the machine it drives.

It is evident, then, that the energy of the total available pressure drop cannot usually be converted efficiently into mechanical work with one set of moving blades, and pressure staging is resorted to. Each stage constitutes by itself a simple turbine. The steam expands in the nozzle or its equivalent through a small range and therefore acquiring a relatively low velocity, suitable to a convenient blade speed. In a reaction turbine this is accomplished by alternating rows of stationary and moving blades. Each row of moving blades takes care of a small pressure drop.

MULTI-STAGES MORE EFFICIENT

In an impulse turbine the stages are usually arranged in series, each stage consisting of a set of stationary blades or nozzles in which a drop in pressure occurs, the steam being directed against the rotating blades of that stage. By suitably subdividing the total available pressure drop, the steam velocities produced can be efficiently utilized in the moving blades of the turbine.

If the velocity of the steam in impulse turbines from the nozzles is high, several sets or rows of moving blades can be used with alternating rows of stationary blades or reversing vanes, as in Fig. 2. Here we have no expansion in the reversing vanes and the kinetic energy is abstracted progressively in the rows of moving blades. This is known as velocity staging and occurs only in impulse turbines.

Reaction turbines are always multi-pressure-stage type with a small pressure drop per stage. Any two rows of blades, the first stationary and the second moving, make a pressure stage. In a modern reaction turbine there are sometimes nearly a hundred stages. The total available pressure drop for each stage is divided into two parts, one being converted into kinetic energy in the stationary blades, and the other in the moving blades. The residual velocity from one stage is utilized in the next stage.

RATEAU-TYPE TURBINE

An impulse type with pressure staging, is shown in Fig. 1, at *B*. Each pressure stage is seen to resemble a single-stage turbine of the DeLaval type as Fig. 1 at *A*. This is of the pure impulse type as described in the preceding article. Note that each set of stationary nozzles at *B* expands the steam progressively and the kinetic energy thereby created is absorbed in the moving blades. A turbine of this type is known commercially as the Rateau or multi-stage impulse turbine.

Fig. 2 illustrates a combination of pressure and velocity staging. It is seen by the curves that the pressure drops and the velocity increases occur entirely within the nozzles *N* and there is no expansion of the steam in the moving blades or stationary blades.

In each pressure stage the steam jet passes over the first row of moving blades to which it surrenders part of its kinetic energy, thereby losing some of its

velocity. It is then guided by the stationary blades to act on the second set of moving blades, which absorb still more of the energy by further decreasing the velocity of the stream. Thus the kinetic energy or velocity energy is absorbed in two steps, or stages, in each pressure stage. The Curtis type of commercial turbines is an illustration of this arrangement.

Expansion in Reaction Stages

The pressure staging of a reaction turbine is illustrated in Fig. 3. It is seen from the curves that the expansion takes place in both the stationary and the moving blades. As explained before, the moving blades receive energy by both impulse and reaction. This process is continued in each of the succeeding pairs of stationary and moving sets of blades. The turbine illustrative of this is known as the Parsons type.

The nozzles and blades of all the stages must deliver the same weight of working substance per second. They may be designed to do this with equal velocities, in which case the blade velocities in all stages would be the same and the mean diameters of the moving blade rings would be equal. The jet velocities may also be varied and the blade velocities and mean diameters proportioned to correspond. The steam in passing through the turbine expands by increment in each nozzle,

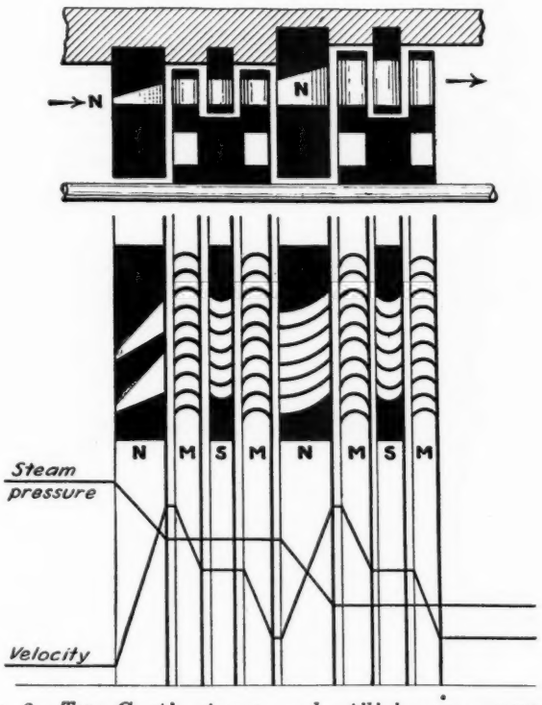


Fig. 2—Two Curtis stages, each utilizing one pressure drop and two velocity drops

thus increasing the volume of steam per unit weight. The nozzle and blade passages therefore must likewise increase in area in order to be able to handle the same weight of steam per second, as the various figures show.

In passing it is well to say that all turbines do not have blades in the general sense of the word. In the turbines already described the jet approached the wheel at some angle to the plane of the wheel. In those known as the tangential impact turbines, the jet approaches the wheel at a tangent. These turbines are of the impulse type.

Some commercial turbines of the tangential impact class are the early Kerr and the Riedler-Stumpf. In the former the steam impinges on buckets arranged around the periphery of the wheel and is strikingly similar to the Pelton waterwheel.

Modern Design Utilizes Old Types

The Riedler-Stumpf turbine is really a refinement of the Kerr turbine, allowing a better efficiency of the jet because of velocity staging. The rim of this turbine consists of a set of double buckets arranged at an angle so as to overlap like shingles of a roof, instead of being

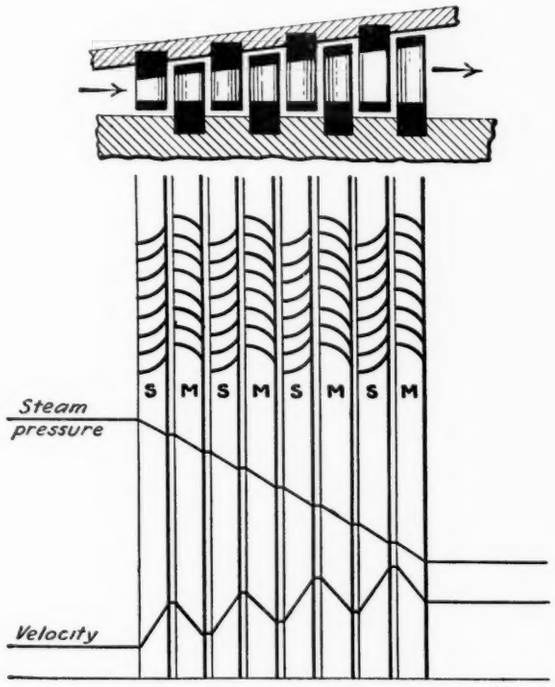


Fig. 3—Steam expands in each blade row of a reaction-type turbine

placed one in front of another as in a Pelton wheel. As the steam leaves the buckets, it is reversed in a reversing bucket and directed against the moving buckets again, thus allowing the wheel to absorb more kinetic energy from the steam.

In steam-turbine designing the possibilities are now quite few, so that in modern practice the greatest skill of the engineer is directed toward applying the commercial types of turbines already developed rather than designing new types of machines. It is safe to say, therefore, that the types here described, which have been standard for many years, will be the standard types for years to come.

Whatever may be the future of pulverized coal in electric power stations situated in cities, such as London, which are at considerable distances from a coal field, there can be no doubt pulverizing must come into use for large power stations which are situated in or near coal regions. This is because pulverizing undoubtedly offers the very best way of using very low-grade fuel.—*The Power Engineer.*

Reconnecting Direct-Current Armatures —Common Mistakes in Connections

Effects in Changing from a Right-Hand to a Left-Hand Winding, or from a Progressive to a Retrogressive Connection

By A. C. ROE

Shop Superintendent, Detroit Service Department, Westinghouse Electric & Manufacturing Company

WHEN placing the coils on an armature, they may be arranged to form either a left-hand or a right-hand winding. Looking at the armature from the commutator end, if the top half of the coils fall to the left, as in Fig. 1, the winding is said to be wound left-handed. When the top half of the coils fall on the right, the winding is said to be wound right-handed. Winding an armature right- or left-handed does not have any effect on the operation of the machine.

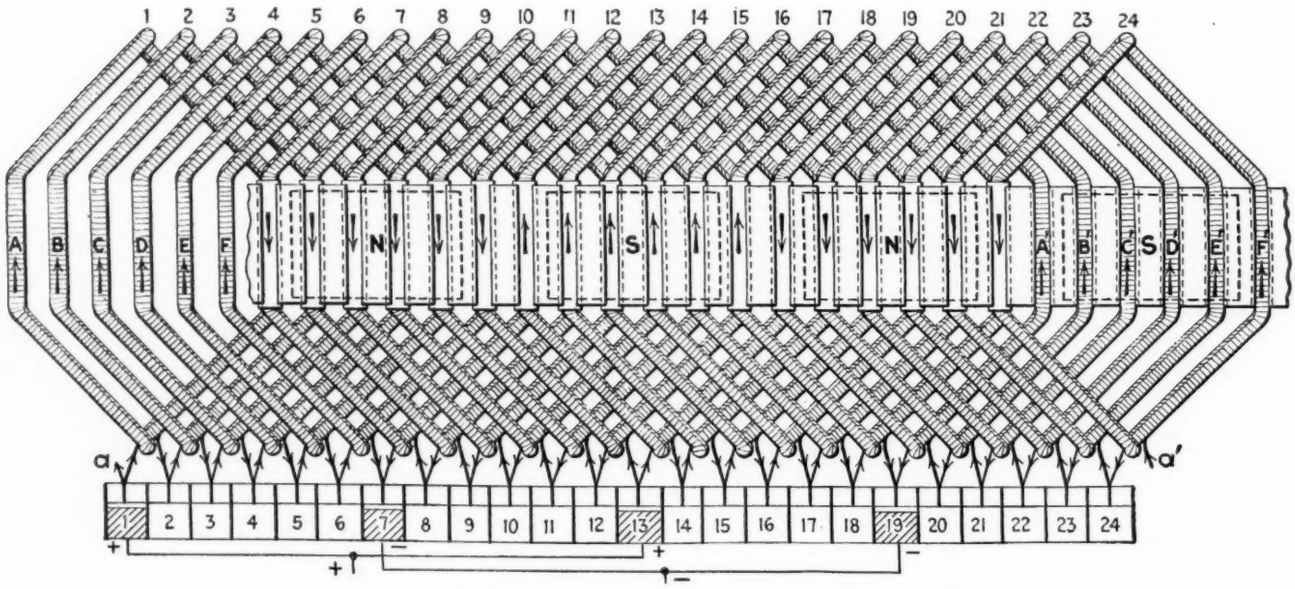


Fig. 1—Four-pole single-lap progressive armature winding

For example, if the armature of a motor was wound left-handed, as in Fig. 1, and it were rewound right-handed, the motor would run in the same direction with the same external connections. If all the coils were turned over in the figure, the top side of the coils would come on the right-hand instead of on the left and the bottom sides on the left instead of on the right. If the coil leads were connected so as to give the same connection as shown, then the direction of the current in the conductors under the field poles would be the same as in Fig. 1, therefore the operation of the machine would not be affected in changing from a left-hand to a right-hand winding.

What is true of a lap winding is also the case for a wave winding. However, when it comes to connecting the coil leads to the commutator, care must be exercised not to change from a progressive connection to a retrogressive or vice versa, or the rotation of a motor will be reversed and a generator will not build up with the same external connections. In Fig. 2 the lap winding is connected progressively as it is also in Fig. 1; that is, the coil leads connect to adjacent commutator bars without crossing. For example, coil 7 connects to bars 7 and 8, the left-hand lead being connected to bar 7 on the left and the right-hand lead to bar 8 on the right. A lap winding is also said to be connected progressively when the back pitch of the winding is greater than the front pitch. In Fig. 2 the back pitch is 1 and 7 or 6 slots; that is, on the back of the armature the top conductor in slot 1 connects to the bottom conductor in slot 7, or 6 slots apart. On the front of the winding the bottom conductor in slot 7 connects to the top conductor in slot 2, or 5 slots apart. In other words, the back pitch of the winding is greater than the front pitch and the winding is said to be progressively connected.

In Fig. 3 it will be found that the leads of coil 7 connect to bars 7 and 8 as in Fig. 2, but in this case the leads are crossed; that is, the right-hand lead connects to bar 7 on the left and the left-hand lead connects to bar 8 on the right. This is called a retrogressive lap winding. The back pitch of the winding is 1 and 7, as in Fig. 2. Considering coil 8, the right-hand lead connects to segment 8, from here the connection is to the top conductor in slot 1, or the front pitch is 1 and 8, which is one greater than the back pitch. This is another way of identifying a retrogressive lap winding; namely, the front pitch is greater than the back.

When a winding is changed from a progressive to a

retrogressive connection or vice versa, the direction of rotation will be reversed in a motor and the polarity of a generator will be reversed and will not build up its voltage unless the field or armature connections are reversed. Why this is so will be understood by tracing out the circuits in the windings. Assume that Figs. 2 and 3 are motor windings. The circuits have in each case been traced out and indicated by arrowheads, and it will be seen that the direction of the current is reversed through the coils in Fig. 3 from that in Fig. 2, and this would cause the armature to run in opposite directions, with the field poles the same polarity in both cases. In a generator with the field poles the same polarity for both conditions, the voltage generated in the conductors would be in both cases the same, but since the coil leads are crossed on the commutator in one connection from what they are in the other, the polarity on the commutator will be reversed.

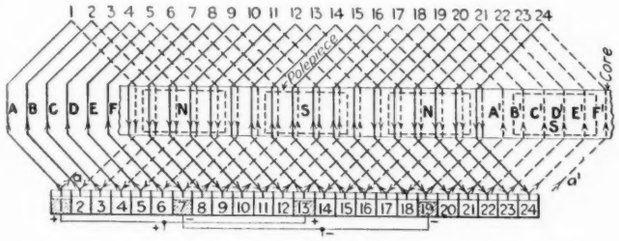


Fig. 2—Same as Fig. 1, but laid out in single lines

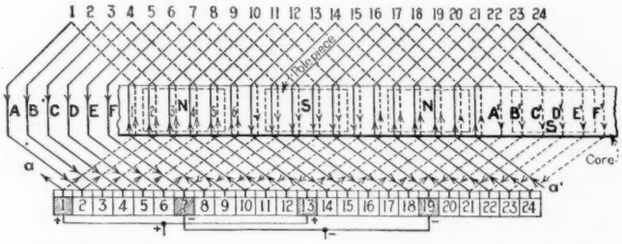


Fig. 3—Winding Fig. 2, connected retrogressively

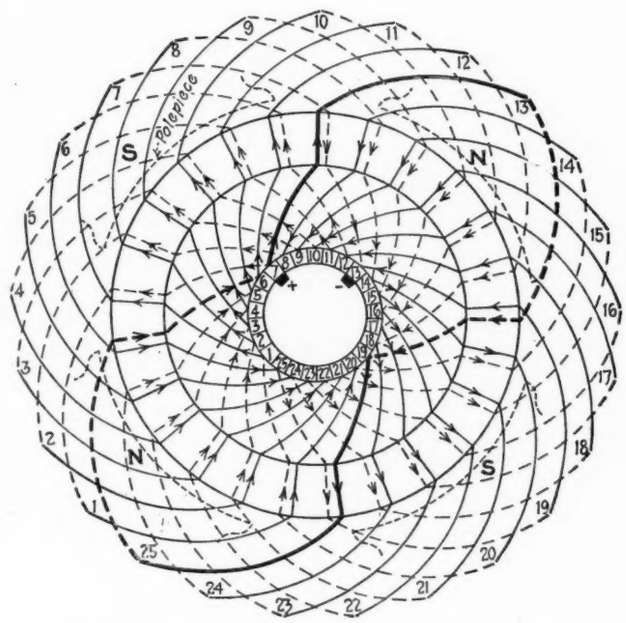


Fig. 4—Four-pole single-wave winding connected retrogressively

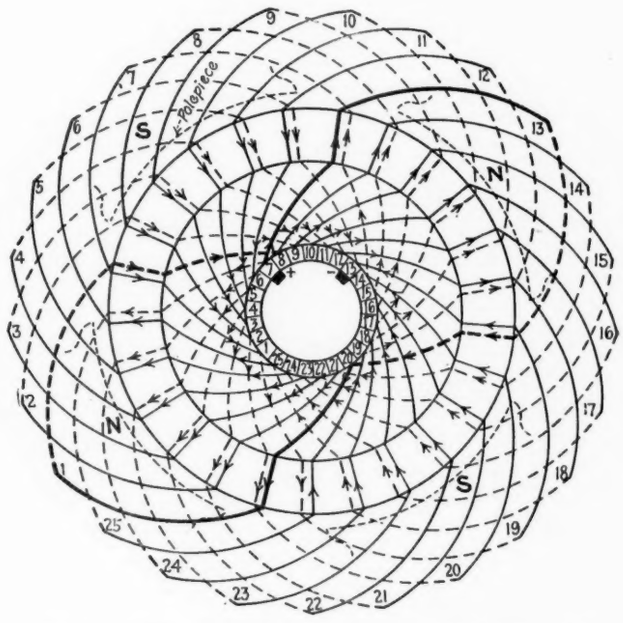


Fig. 5—Four-pole single-wave winding connected progressively

There are also two ways of connecting a wave winding: Retrogressive, short pitch; and progressive, long pitch. Changing from one connection to the other has the same effect as when changing from progressive to a retrogressive connection for a lap winding. In Fig. 4 the leads from the coils are connected short pitch, or 1 and 13; that is, starting at the brush or segment 7, one circuit is through coils 13, 25, 12, 24, 11, 23, etc., to coil 7 and the brush on segment 13. The other circuit is through coils 1, 14, 2, 15, 3, 16, etc., to coil 19 and segment 13. In Fig. 5 one of the circuits is through coils 13, 1, 14, 2, 15, 3, etc., to coil 6 and the brush on segment 13, and the other circuit is through coils 25, 12, 24, 11, 23, 10, etc., to coil 19 and the brush on segment 13. From the foregoing it will be seen that the coils forming the two circuits from the brush on segment 7 have been interchanged in Fig. 5 from those in Fig. 4. Where the circuit through coil 13 in Fig. 4 leads to coil 25, in Fig. 5 it leads to coil 1. This interchange of the coils in the circuits results in a reversed direction of the current through the coils, if the winding were used on a motor, as can be seen by comparing the direction of the current in the coils under the different poles. Under the *S* poles in Fig. 4 the arrowheads indicate current flowing toward the polepieces, whereas in Fig. 5 the direction is toward the commutator. This reversed direction of current through the coils would result in causing the motor to run in an opposite direction with the connection Fig. 5 from that for the connections in Fig. 4, with the same external connections. If the machine were a generator, it would not build up if the armature coil connections were changed from those in Fig. 4 to those in Fig. 5, unless either the armature or field external connections were changed, and then the polarity on the brushes would be reversed, with the same field-pole polarity.

Superpower vs. Coal Conservation*

By EGBERT DOUGLAS†

WITHIN recent years the superpower plant of interconnecting large central stations has been advanced as a great step in the direction of conserving our fuel resources. Power and coal have become synonymous terms, and it is the common belief that if we save coal in any considerable quantities, we must be more efficient in the production of power. This has been the cue of the superpower surveys and plans for immense electric transmission systems.

Opposed to this scheme are certain engineers and economists who take the opposite view and believe that to analyze our power problems alone will lead to erroneous results, and unless the question of heat is taken into account along with that of power, no appreciable economic change will result from the indiscriminate centralization of power in a comparatively few superpower plants.

Again, water-power development is being urged from one end of the country to the other, and this agitation has led to a lot of erroneous notions by the man-of-the-street, that if all the water powers are developed we will have immediately cheap power in abundance and thereby save enormous amounts of coal. It remains to be said, however, that proper engineering discrimination must be used in this water-power development, as many enterprises in this line have proved poor investments. Besides, if all the water power of the nation were developed, the aggregate output would be but a drop in the bucket of our power requirements, and the problem of supplying heat would still remain unsolved.

DISCUSSIONS of the superpower projects have centered on the production of power alone. Nothing has been said about heating. As a matter of fact the superpower station discards to the condenser almost 70 per cent of the heating value of the coal. By utilizing the exhaust steam for heating and by intelligent engineering, the isolated plant may show an efficiency beyond the reach of any condensing plant devoted solely to the production of mechanical power.

In all this agitation power is the only thing talked about, and the enthusiasts try to convince us that power is the main outlet of our fuel consumption. But power is only a part of it. If all the small-sized plants in the country were closed down and in their stead superpower was supplied, we would be worse off from a fuel-conservation viewpoint than we are today, because the real source of fuel demand comes not from the requirements of power, but from the necessity of heat.

For example, in a fair year the country consumes about 500,000,000 tons of coal, and this is used up practically as follows: Steam railways, 29 per cent; industrials, other than steel and coke plants, 28; coke plants, not including gas plants, 15; domestic consumers, 12; electric public utilities, 8; steel plants 7; coal-gas plants, 1.

Industrials are consuming over three times as much coal as that used by all the electric public utilities, for example, 28 per cent as compared with 8 per cent. This 28 per cent of the total coal is used in industry and is not all required for power purposes. In many industries the major part of it is required for heating and process work. This heat is just as essential as power, and a great deal of it should be produced as a byproduct of the power production, from the same boiler plant. If one-half the coal now used in industry is required for heat, there remains an item of less than 14 per cent of the total consumption for the superpower plan to work on, which in quantity is about what we require to heat our houses. The fuel consumption for domestic purposes is 50 per cent more in quantity than that used by all the electric public utilities, and all this domestic fuel is required for heat and will not be affected in the slightest degree by the superpower plan.

Advocates of the superpower plan have pointed to the low efficiency of the small industrial power plant and have pictured in glowing terms the higher efficiencies of the large central plants. But all this discussion has been on the production of power alone. Nothing has been said about heating, and no mention has been made of the low thermal efficiency of the best superpower plants. As a matter of fact the efficiencies of steam engines or steam turbines, regardless of their size, is low so far as heat extraction from the steam is concerned. From 80 to 85 per cent of the heat entering the throttle valve of the turbine in the largest superpower plant is cooled off in the condenser and wasted.

Apparently, it has become a common popular belief that steam pressures have an important and direct bearing on steam costs. Steam pressures have become confused with steam quantities, and many people now believe that steam, for example, at 5 lb. pressure will take much less coal to produce than would be required to produce steam at a higher pressure. In reality, there is less than 4 per cent additional heat in a given quantity of steam at 150 lb. pressure than in the same quantity of steam at 5 lb. pressure. This is the fundamental reason why all large power plants are designed and built for high steam pressures, as by adding an insignificant amount of heat the steam can be raised in pressure many-fold and thereby add to its capacity for doing mechanical work.

On account of these truths it is little short of an economic crime to blow steam into a large heating system from one boiler plant and then operate another boiler plant a few blocks or a few miles away to make the power required in this heated space, with an overall efficiency in the power producing plant of less than 20 per cent.

Obviously, it would take less coal to supply heat, power and light when these services are produced from one boiler plant than it will if they are divided between two boiler plants. The greatest fuel waste we have in the country today in the large industrial centers, is the

*Abstract of paper read before the Wisconsin Engineering Society, Madison, Feb. 22, 1924.

†Member of the firm Cahill & Douglas, consulting engineers, Milwaukee, Wis.

indiscriminate blowing of steam into millions of cubic feet of heated space without first taking from this steam the mechanical work it is capable of producing.

If one-half of the engineering thought and commercial effort were spent in the direction of consolidating many of these isolated steam power plants and in taking the mechanical work from the steam they produce, and utilizing the exhaust steam for heating, the saving in coal effected would be much greater than would be possible from the superpower plan.

Distribution Losses a Serious Factor

In the business of generating and transmitting electric power there are other things to consider besides the thermal efficiency of the power producing plant. For example, in the large transmission systems now the order of the day, the losses in distribution run from 18 to 25 per cent, depending on the character of the load. To illustrate, the published data on the amount of electrical energy generated, and that lost in transmission by central stations in the United States in the years 1912 and 1922, are summarized in the following:

Items	Year 1912	Year 1922
Kilowatt-hours generated	11,659,000,000	43,290,000,000
Kilowatt-hours line losses	2,546,000,000	7,970,000,000
Kilowatt-hours available for use	9,023,000,000	33,320,000,000
Per cent line loss	22	18

It is interesting to notice that in ten years the amount of energy generated by central stations increased almost 300 per cent, while the line losses in this period decreased only 4 per cent. Thus it would appear that the distribution problem strikes a body blow at the higher efficiency that the superpower plant has over the small isolated plant.

The investment burden is also of serious moment. According to the United States Census reports the average cost of commercial central stations of the country in 1917 was $349 per kilowatt of station capacity installed. This is of course high, and at present the cost would no doubt be somewhat less, but still greatly in excess of the unit cost for a small first-class power plant of 500 kw. capacity.

Size of Plant Has Little Effect on Amount of Steam Produced from a Pound of Coal

The question of size in boiler plants does not have anything near the effect on the amount of steam that a pound of coal produces that the average executive and many engineers believe. Looking at the fundamentals, the essential elements in a boiler plant are: First, a chimney of suitable area and height to carry away the products of combustion from a given amount of coal; second, a boiler of sufficient heat-absorbing surface to make the required amount of steam; third, a furnace of sufficient volume and ample air supply to burn economically a given amount of coal.

With proper design substantially as high furnace temperatures can be secured in a small furnace as in a large one, the limiting feature in both being the refractory material in the furnace lining. Therefore, the small boiler can absorb substantially as much heat per square foot of heating surface as the large one. The fixed radiation losses in the small plant will be relatively higher, and also the labor expense per unit of output, but the amount of steam that a pound of coal will produce will not be much inferior to the results obtained in the large plant.

It should be stated, however, that improvements in furnace design for boilers have been made largely in connection with the large central-station plants. The small industrial and commercial building plants, generally speaking, have followed the old lines of practice and have left the furnace design to the boiler salesman, the insurance inspector or the building architect. The result is that there has been little improvement in combustion engineering in the multitude of small plants. There are literally thousands of small plants that, if their furnaces were redesigned and provided with proper draft and air supply, could produce results in coal conservation that would be little short of startling.

Ample room exists for improvement in both power and heat production to the end of saving coal. But to deal with the matter of power alone and ignore the question of providing heat more economically, will lead to disappointment in the costs of both and also in fuel consumption.

The panacea of all our troubles does not lie with superpower, nor will the isolated plant be the best solution in all cases—rather a combination of the two with proper consideration given to both power and heating, as well as the use of steam for industrial purposes, will be the intelligent answer.

Power Demand and Capacity in Southern States

The United States Geological Survey estimates the water-power resources of the six Southern States—Tennessee, North and South Carolina, Georgia, Alabama and Mississippi—composing what is sometimes known as "The Southern Superpower Zone," as approximately 4,220,000 hp. Since, however, these figures do not take into account utilization of storage, for which many excellent opportunities exist, the total water horsepower available is doubtless in excess of this figure.

The U. S. Census Bureau reports that the central station companies of these states—that is, those companies generating and distributing electric power for general use and for electric railways—had an installation in 1922 of 1,720,000 hp. This bureau also reports that the installation of waterwheels and steam engines in manufacturing establishments in these same states in 1919—five years ago—was 1,800,000 hp., or an aggregate installation in central stations and manufacturing plants of 3,520,000 hp., or over 80 per cent of the potential water horsepower. These figures do not mean, however, that the six Southern States already have a demand for power so nearly equal to their total potential water powers. The 1,720,000 hp. installed in central stations in 1922 developed 3,200,000,000 kw.-hr. of electric energy, equivalent to a continuous output of 490,000 hp., or 28 per cent of the full capacity of their installation.

It is not probable that the waterwheels and the steam engines in manufacturing establishments developed a greater percentage of their continuous rated capacity, or an equivalent continuous output of 500,000 hp. If we add the probable increases since the dates to which these figures apply, the actual present power requirement of these six Southern States for industry, domestic use and street railways is not likely to exceed 1,300,000 continuous horsepower, or one-third of their estimated water-power resources.—*From an address by O. C. Merrill at Jackson, Miss., March 10, 1924.*

Making a Power-Plant Heat Balance

BY THEODORE MAYNZ

IN *POWER*, Feb. 5, a simple method of checking the performance of the boiler room was outlined. The method, however, did not attempt to show where the leaks were occurring in the plant, for which purpose a complete heat balance is necessary. Should a heat balance of the boiler room be desired, the series of curves shown in Figs. 1, 2 and 3 will be of value. These can also be used in boiler tests, as they are sufficiently accurate and give far closer results than can be obtained from slide-rule calculations.

The heat loss due to dry products of combustion can be obtained in the usual manner from the formula,

Heat loss = 0.24 (*flue-gas temp.* — *air temp.*) × *weight of gas.*

The weight of flue gas per pound of dry coal fired is found from the coal and gas analysis as follows:

$$W = \left(\frac{4\,CO_2 + O_2 + 700}{3\,(CO_2 + CO)}\right) \times \left(C - C_R + \frac{S}{1.833}\right)$$

where

C = Lb. carbon per lb. of dry coal;
C_R = Lb. carbon in refuse, referred to coal, or
C_R = Lb. refuse per lb. of dry coal × lb. combustible per lb. of refuse;
S = Lb. sulphur per lb. of coal.

The losses due to moisture and hydrogen can be calculated in the usual manner or quickly derived from the curve sheet shown in Fig. 1. The straight line K for each one per cent of hydrogen shows the values to

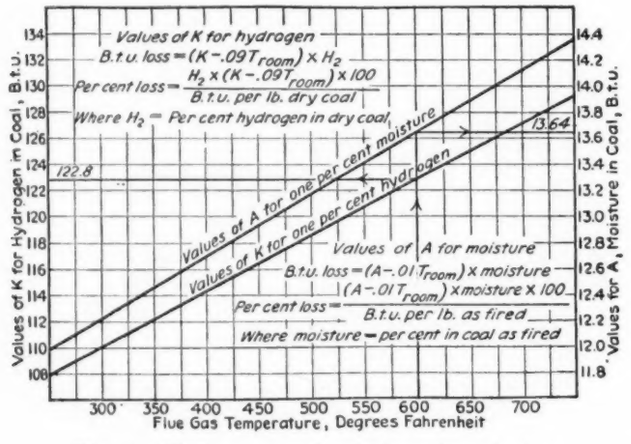

Values of K for hydrogen
B.t.u. loss = (K − .09 T room) × H2
Per cent loss = H2 × (K − .09 T room) × 100 / B.t.u. per lb. dry coal
Where H2 = Per cent hydrogen in dry coal
122.8
13.64
Values of A for one per cent moisture
Values of K for one per cent hydrogen
Values of A for moisture
B.t.u. loss = (A − .01 T room) × moisture
Per cent loss = (A − .01 T room) × moisture × 100 / B.t.u. per lb. as fired
Where moisture = per cent in coal as fired
Values of K for Hydrogen in Coal, B.t.u.
Values for A, Moisture in Coal, B.t.u.
Flue Gas Temperature, Degrees Fahrenheit

Fig. 1—Hydrogen and moisture loss factors

be used for various flue-gas temperatures. This value of K is substituted in the formula,

$$B.t.u.\ loss = H_2 \times (K - 0.09\,T_a) \text{ or}$$

$$Per\ cent\ loss = \frac{H_2 \times (K - 0.09\,T_a) \times 100}{B.t.u.\ per\ lb.\ of\ dry\ coal}$$

where H_2 = per cent hydrogen in dry coal and T_a = temperature of incoming air in deg. F. For moisture loss the line showing value of A is used, and substituted in the formula,

$$B.t.u.\ loss = moisture \times (A - 0.01\,T_a), \text{ or}$$

$$Per\ cent\ loss = \frac{moisture \times (A - 0.01\,T_a) \times 100}{B.t.u.\ per\ lb.\ of\ coal\ as\ fired}$$

where the moisture is in per cent of coal as fired.

As example, using 600-deg. flue gases, 100 deg. air or room temperature, 3 per cent moisture, 4½ per cent hydrogen, 12,000 B.t.u. per lb. of coal as fired and 12,400 B.t.u. dry, the value of K is 122.8 and A is 13.64 at 600 deg. F. gas temperature.

Substituting in the formula for heat loss due to hydrogen, it is found that the B.t.u. loss from 4½ per

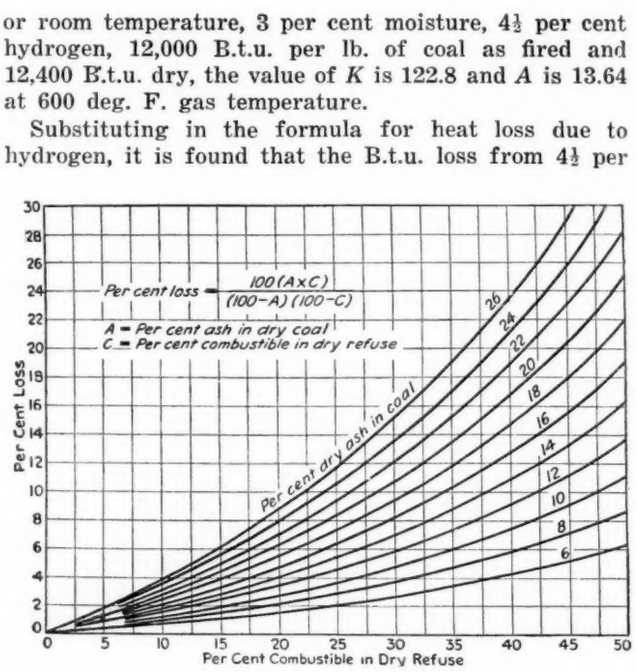


Fig. 2—Per cent loss from ash

cent hydrogen is 4.5 × (122.8 — 0.09 × 100) = 512.1 B.t.u.

The per cent of hydrogen loss is then $\frac{512.1 \times 100}{12{,}400}$ or 4.13 per cent.

Likewise the B.t.u. loss from 3 per cent moisture, by substituting the assumed values in the equation, is 3.0 × (13.64 — 0.01 × 100), or 36.91 B.t.u.

The per cent moisture loss = $\frac{36.92 \times 100}{12{,}000} = 0.308$ per cent. It can be readily seen that the use of these curves gives accurate results without the necessity of steam tables and with simple calculations.

The loss due to combustible in the refuse can be calculated quite closely by the formula,

$$Per\ cent\ loss = \frac{a\,c \times 100}{(100 - a)\,(100 - c)}$$

where a = per cent ash in coal and c = per cent combustible in ash.

This chart, from which the loss may be read, is shown in Fig. 2. The chart shown in Fig. 3 is more accurate and gives the actual B.t.u. loss for each one per cent of ash in the coal, for various percentages of combustible in the dry refuse.

$$Total\ loss, B.t.u. = K \times per\ cent\ ash\ in\ the\ coal$$

$$Per\ cent\ loss = \frac{K \times per\ cent\ ash\ in\ the\ coal \times 100}{B.t.u.\ per\ lb.\ dry\ coal}$$

These charts and calculations will take care of practically all desired information pertaining to boiler-room operation.

The problem worked out in Fig. 6 of the first of these articles on testing (*Power*, Feb. 5, 1924) showed a boiler efficiency of 72.25 per cent with 12,000-B.t.u. coal as fired. To show the extent and location of the

boiler losses the following conditions are assumed to have existed:

Flue-gas temperature, deg. F.	600
Air or room temperature, deg. F.	100
Moisture in coal, per cent	3.0
Carbon in the coal, per cent	70.0
Hydrogen in the coal, per cent	4.5
Sulphur in the coal, per cent	3.5
Refuse in ashpit, per cent	16.0
Combustible in the refuse, per cent	20.0
CO_2 in flue gas, per cent	12.4
O_2 in flue gas, per cent	6.2
CO in flue gas, per cent	0.0

A heat balance is obtained by calculating the several

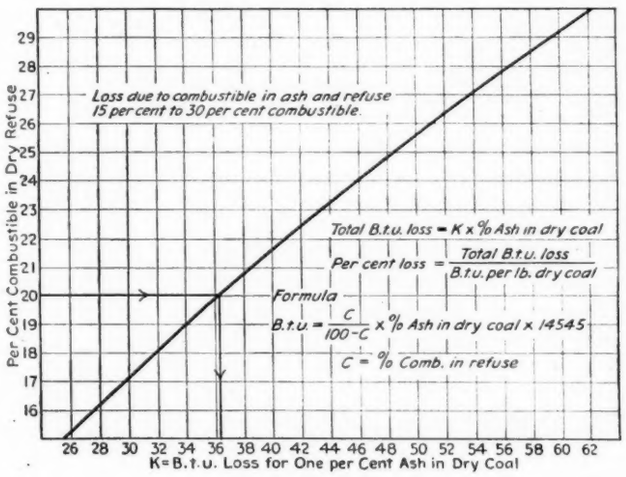

Per Cent Combustible in Dry Refuse
K=B.t.u. Loss for One per Cent Ash in Dry Coal
Loss due to combustible in ash and refuse 15 per cent to 30 per cent combustible.
Total B.t.u. loss = K x % Ash in dry coal
Per cent loss = Total B.t.u. loss / B.t.u. per lb. dry coal
Formula
B.t.u. = C/(100-C) x % Ash in dry coal x 14545
C = % Comb. in refuse

Fig. 3—B.t.u. loss due to ash

losses. As has already been shown, the weight of the dry flue gas per pound of carbon is $\frac{4 \times 12.4 + 6.2 + 700}{3 \times 12.4}$ = 20.32 lb. The actual carbon burned, corrected for sulphur is $0.70 - (0.20 \times 0.16) - \frac{0.35}{1.833} = 0.687$ lb. The weight of gas per pound of coal burned = $20.32 \times 0.687 = 13.96$. The flue-gas loss is equal to $\frac{0.24\ (gas\ wt.)\ (gas\ temp. - air\ temp.)\ 100}{B.t.u.\ in\ 1\ lb.\ dry\ coal}$, or $\frac{0.24 \times 13.96 \times (600\ deg. - 100\ deg.) \times 100}{12{,}400} = 13.51$ per cent.

The hydrogen and moistures loss as worked out by Fig. 1 was found to be 4.13 per cent and 0.308 per cent respectively.

The ashpit loss is $K\frac{(per\ cent\ ash\ in\ coal)}{B.t.u.\ per\ lb.\ dry\ coal}$, which from Fig. 2 is seen to be $\frac{16 \times 36.3 \times 100}{12{,}400} = 4.68$ per cent.

The total heat balance is then

Boiler and superheater efficiency, per cent	72.25
Dry flue gas loss, per cent	13.51
Hydrogen, per cent	4.13
Moisture in coal, per cent	.31
Ash pit, per cent	4.68
Radiation and unaccounted for (by difference), per cent	5.12
Total, per cent	100.00

This shows how simple it is to work out a complete boiler heat balance.

For those who desire to construct a complete plant heat balance which might better meet their particular conditions, to the diagram of a simple plant shown in Fig. 4, may be added any further apparatus, such as house turbines, evaporators, stage-bleeding heaters, reheaters, etc., that might be used. But the diagram as shown is a basis on which the heat balance of any plant can be calculated.

The following nomenclature is used both in the chart and in the calculations:

E_1 = Kw.-hr. generated
E_2 = Kw.-hr. delivered
e = Kw.-hr. used in plant
W_C = Weight of fuel burned
W_R = Total plant water rate
W_T = Turbine water rate
W_A = Auxiliary water rate
W_L = Miscellaneous water rate (soot blowers, drips, leaks, etc.)
W_{BD} = Blowdown water rate
W_M = Makeup water rate = $W_{BD} + W_L$
H_C = Heat in fuel burned
H_S = Total heat in high-pressure steam
H_E = Total heat in exhaust steam from auxiliaries
h_S = Total heat in water at boiler pressure (above 32 deg. F.)
h_F = Total heat in feed water (above 32 deg. F.)
h_C = Total heat in condensate (above 32 deg. F.)
h_M = Total heat in makeup (above 32 deg. F.)

As the heat-balance diagram shows, the inputs, out-

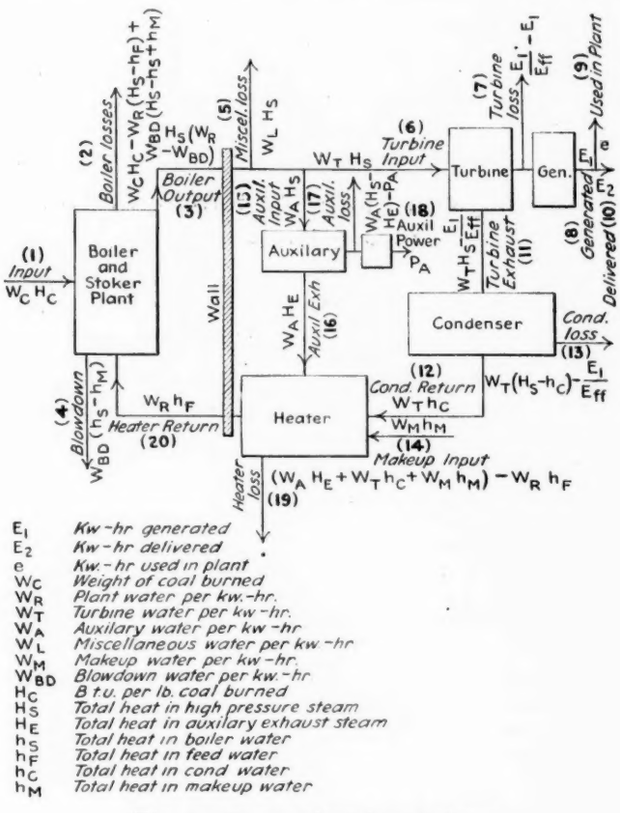


Fig. 4—Power-plant heat balance

puts and losses in terms of B.t.u. per kw.-hr. are as follows:

(1) Input to boilers = $W_C H_C$
(6) Input to turbines = $W_T H_S$
(11) Input to condensers $W_T H_S - \frac{E_1}{eff.}$
(15) Input to auxiliaries $W_A H_S$
(12 + 14 + 16) Input to heaters $W_A H_E + W_T h_C + W_M h_M$
(3) Output of boilers $H_S (W_R - W_{BD})$
(8) Output of turbines $E_1 = 3{,}415$
(18) Output of auxiliaries P_A
(12) Returned by condensers $W_T h_C$

(16) Returned by auxiliaries $W_A H_E$

(19) Returned by heaters $W_R \times h_F$

(2+4) Lost in boilers (total) $W_C H_C - W_R (H_S - h_C) + W_{BD} H_S$

(9) Used in plant e

(7) Lost by turbines $\frac{E_1}{e\eta} - E_1$

(13) Lost by condensers $W_T (H_S - h_C) - \frac{E_1}{e\eta}$

(17) Lost by auxiliaries $W_A (H_S - H_E) - P_A$

(19) Lost by heaters $W_A H_E + W_T h_C + W_M h_M - W_R h_C$

(5) Lost by miscellaneous $W_L H_S$

Total inputs to plant = (1) + (14)

Total output = (10) = E_2

Total losses = $(2 + 4 + 5 + 7 + 9 + 13 + 17 + 18 + 19) = W_C H_C - W_R (H_S - h_C) + W_{BD} (H_S - h_S + h_M) + W_{BD} (h_S - h_M) + W_L H_S + \frac{E_1}{e\eta} - E_1 + e + W_T (H_S - h_C) - \frac{E_1}{e\eta} + [W_A (H_S - H_E) - P_A] + P_A + W_A H_E + W_T h_C + W_M h_M - W_R h_F$

Equating the total inputs equal to the output plus the losses proves the accuracy of this heat balance.

The construction of these charts, heat balances, etc., requires a little time, but the labor involved is more than compensated for by the results obtained. With these charts anybody that can handle simple arithmetic, a slide rule or a mechanical calculator, can be quickly trained to make all the required power-station calculations in far shorter time than a trained engineer could do the same work with steam tables and the long calculations required by their use.

Switching Out Faulty Circuits from the Power House

The principal objection to switching out faulty transmission lines manually by the plant operator is that the method is too slow—so slow, in fact, that a partial or total interruption to service is likely to result from the majority of faults. While the operation of relays is not infallible, their use certainly affords the most satisfactory method of clearing transmission-line faults, and if properly installed and maintained, relays can be depended upon, in the majority of cases, to clear serious faults in less than two seconds. When a transmission line or connected apparatus, such as a transformer, fails, delay in clearing the trouble will not only cause a loss of load, but will probably cause greatly increased damage at the fault, and this is another reason for the increasing use of relays.

On systems provided with relay protection, the most common arrangement is to use excess current relays at the generating stations and directional current relays at the substations. Often the directional current relays are instantaneous in their action, but the excess current relays are generally given a definite or inverse time setting such that the relays at the generating station will be the last to function. Induction-type relays are used on most new installations and possess the important advantage over plunger-type relays that their current and time settings can be quickly and accurately changed. This point is important where it may be necessary to change the current settings to correspond to the number of generators in service, for at times of light load there might not be enough generators in operation to cause the relays to function unless their current settings were decreased. In one large station the taps to the current coils of certain relays have been brought out to small dial switches, thereby making it possible to change the current settings quickly.

Steam Boilers

A Catechism by Warren Hilleary Served in Small Doses and Extending Over a Number of Issues

84. The steam connection from two boilers enters a common header. The pressure on one boiler is 100 lb.; the connection to the header from this boiler is open and the boiler is supplying steam to an engine. The other steam connection to the header is closed, and the pressure on the other boiler is 25 lb. What danger is there in opening the valve on the steam connection of the latter boiler and allowing the steam from the boiler that is operating to enter the other boiler and equalize the pressure on the two boilers?

The boiler should not be cut into the header until its pressure is exactly equal to the pressure in the header. The turning of the high pressure from the header into the boiler would probably increase the pressure in the boiler so rapidly as to set up dangerous strains.

85. Suppose you enter a boiler room and find no attendant, observe a pressure of 100 lb. on the gage, no water in the glass, and a bright coal fire in the furnace. The boiler room is adjacent to a factory employing a considerable number of operatives. What action would you take?

Cover the fire with ashes, or fresh coal; close all front draughts and endeavor to warn all persons to leave the premises.

86. Why do not vertical boilers and locomotive boilers generally have water columns?

On vertical boilers the absence of a water column is generally due to the high cost of the column and the necessary flanges required for its connections. It costs less to drill and tap a sheet for the direct insertion of gage cocks and water gage-glass connections. On locomotive boilers lack of space accounts for its absence.

87. What danger must be guarded against in starting the fire in cold boilers equipped with superheaters?

There must be a connection from the water space in the boiler at a point higher than, and into, the bottom header of the superheater. This connection must be so valved that, prior to starting the fires, one valve may be opened to allow the water from the boiler to fill the superheater and to permit the shutting off of the water from the boiler to the superheater after steam begins to flow through the main steam line. When it does so flow, the superheater may be drained of water.

88. In a B & W type boiler the water must be kept high enough to insure the top row of tubes being full. Otherwise this top row may burn. If a superheater is installed, the bottom portion of the superheater may be only a fraction of an inch above the tops of the top row of tubes, and if the top row of tubes will burn when not full of water, why will not the superheater tubes burn, since a portion of them is practically in the same location as the top row of boiler tubes?

The rate of flow of the steam in the boiler tube as compared with the rate of flow in the superheater tube is low, and therefore the tendency of the boiler tube to overheat is greater. The superheater tube would overheat except for the fact that the steam is kept passing through it at a considerable velocity.

89. What defects may be expected to appear in superheaters?

Broken handhole plates, broken plate yokes, cracked headers and worn out tubes. The wear occurs on the inner side due to the cutting action of the steam.

Turbines Not Protected by Usual Overspeed Tests

TWO elements function to protect a steam turbine against overspeed—the main valve gear and the emergency valve gear. A prime mover may reach an undesirably high speed by a comparatively slow acceleration, such as one per cent increase in speed per minute, or by the fastest possible rate of increase, such as that due to full steam admission when no load is being carried. Here, the time interval from normal to allowable overspeed would be largely governed by the inertia of the revolving parts.

The usual routine tests for prevention of overspeed consist of tripping the emergency valve by hand, preferably before starting and when stopping a prime mover, and also a test at actual overspeed about once a month. The former test is to insure smooth working of the emergency valve and tripping mechanism, and the latter to test the emergency governor and valve together so as to determine at what speed the mechanism functions.

A little consideration will show that such tests of these devices do not cover the full protective functioning. In the first place, the main valve gear is usually lost sight of as a means of preventing running away. A leaky main valve, allowing acceleration after the governor has closed it, is often passed over as inconsequential. The emergency valve is usually depended upon to make up for deficiencies.

Secondly, overspeed tests are ordinarily made at a slow increase of speed. An emergency valve or governor that is sluggish, may give satisfactory operation during such a test. On the other hand, a great acceleration, such as would occur if the generator circuit-breaker were tripped at an overload, might be too fast to be checked within the safe limit, by mechanisms not functioning properly.

In order to provide a thorough test of protection against overspeed, the main valve gear and the emergency governor occasionally should be tested individually against sudden rises in speed in addition to those of the usual routine. The main valve gear ordinarily holds a unit below emergency tripping speed, even when the generator breaker opens on an overload. In order to check this, the generator load may be tripped off at intervals of one-quarter, one-half, three-quarters, normal load, etc., and final speed readings of each operation obtained by a hand tachometer in the turbine shaft. The machine should not be permitted to attain undesirably high speeds, in case the governor proves sluggish in the beginning. Slow overspeeding due to leaky valves or other causes should be investigated and corrected.

The emergency valve gear may be tested in the same general manner. The main valve gear can be arranged for blocking the valves in position to carry one-quarter load, one-half load or other desirable steps. The emergency governor may be tested at each load interval and its relative quickness determined.

Operation nowadays tends toward prevention of trouble in preference to the delay and expense of its subsequent correction. When the facts are squarely faced, there is usually little difficulty in securing adequate means of protection.

Another Milestone in Hydraulic Turbine Design

WITH the Francis-type runner the specific speeds of hydraulic turbines have been carried about to the limit, around one hundred, in the foot-pound system. Although experiments are being carried on with higher specific speed runners, the possibilities of greatly exceeding one hundred does not appear likely. Even with the specific speeds that have been obtained with Francis-type wheels, in low-head plants the dimensions of the units for a given output are still very large. To overcome this difficulty and to obtain a runner of simpler design, waterwheel manufacturers have, during the last six or seven years, given a great deal of attention to the development of what is generally known as a propeller-type runner. Probably this development has been the most phenomenal event in waterwheel history. Less than five years ago this type of wheel had hardly passed the experimental laboratory stage; today there are two 28,000-horsepower units in operation, as described in the leading article in this issue, "Great Falls Hydro-Electric Power Development of the Manitoba Power Co." Wheels of larger capacity than these to operate under a somewhat higher head are now under construction.

In the comparison made in the article between the Francis-type Cedar units and the Great Falls propeller-type, two things in particular stand out—the simplicity of the design and the reduction in weight of the latter type over the former for a given capacity. If both units are operated under the same head, they will develop approximately equal power. Although the two types of runners have practically the same outside diameters, there is over 100,000 pounds difference in their weights. Not only this, but the Cedars runners are made up of four complicated castings bolted together, whereas the Great Falls runners are one piece of comparatively simple construction. Comparing the weights of the two types of turbines, there is approximately 400,000 pounds difference. This reduction in weight and simplified construction results in a lower cost not only for the units, but also for foundations and building.

When compared with the Francis-type, the propeller-type unit is at a disadvantage in efficiency, particularly at part gate. The maximum efficiency of the latter can be made about the same as that of the former, but below or above this point the efficiency falls off rapidly. If the wheels are used where there is an excess of

water or they operate on a large system where they can be operated at nearly full-load capacity, the low part-gate efficiencies are not of such importance. Today the propeller-type unit has an efficiency curve not unlike the Francis-type wheel of twenty years ago. Improvements in design have resulted in raising the efficiency of the latter to over ninety per cent, at between fifty and over one-hundred per cent load for units of large sizes. There appears to be no good reason why the efficiency of the propeller-type unit cannot be materially improved when designers have had more experience with it. Even in its present state of development it has established another milestone in hydraulic-turbine design.

Thoughts on the Benson Test

IN THE issues of May 22 and 29, 1923, *Power* gave the engineering features of the Benson Generator, a British boiler designed to generate steam at the critical pressure of 3,200 pounds. The scheme was to deliver the cold feed water to one end of a set of continuous coils of small bore arranged to be heated on the strict counterflow principle by the combustion gases of an oil-fired furnace. By keeping the feed pressure above the critical pressure of 3,200 pounds, the water passing through the coils was to rise in temperature continuously until the critical temperature of 706 degrees was reached, whereupon it was to change into steam quietly without ebullition, change of volume or the addition of latent heat. After slight superheating in these primary coils the steam was to be throttled to 1,500 pounds and then dried and superheated in another set of similar coils placed above the primary coils and in contact with the hottest gases. The 1,500-pound superheated steam was to be used in a high-pressure turbine exhausting through a reheater to a low-pressure condensing unit.

The argument for generating at 3,200 pounds when only 1,500 pounds was desired for the turbine, was that steam could be generated at this critical pressure without ebullition, thus allowing the boiler to be made of continuous coils of small-bore tubing and without drums or other provision for steam "releasing."

A letter from the designers (on page 457 of this issue) reports that the first generator constructed on this principle has undergone a preliminary test (at Rugby, England), in which steam was actually generated for six hours under conditions approximating those just described. In the absence of other information, one may accept the results given as correct for purposes of discussion, and proceed to draw tentative conclusions from the reported performance. While the results obtained seem surprising, to say the least, when viewed in the light of ordinary steam-generating conditions, there is nothing that appears to be at variance with established engineering principles. With careful construction and the use of suitable alloy steels in the high-temperature coils, it was to be expected that steam could be generated in the manner described without the generator developing any leaks.

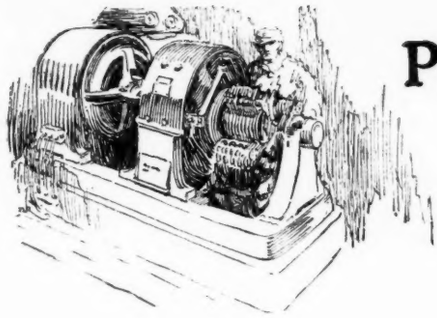
At first sight the flue temperature of 110 degrees F. may strike the reader as a misprint, since in ordinary boilers the flue temperature is necessarily higher than the saturation temperature of the steam, which in this case is about 706 degrees. However, in this case the "boiler" (that is the 3,200-pound steam-generating coils) is really nothing but a steel-tube economizer working under extraordinary conditions. No latent heat is supplied and the temperature of the fluid rises continuously from the feed temperature to the final temperature of 725 degrees. With complete counterflow operation and unheated feed water at, say, 60 degrees F. (the actual feed temperature is not stated) there seems to be nothing theoretically impossible about the reported flue temperature of 110 degrees. Such a low flue temperature implies, of course, the precipitation of most of the moisture that must be present in large amounts in the combustion gases from fuel oil. It is not stated whether steps have been taken to prevent this moisture from corroding the coils.

In the absence of actual efficiency figures, it is interesting to indulge in a little speculation on the subject. With, say, thirty per cent excess air and a room temperature of 70 degrees F., a flue temperature of 110 degrees would give a flue loss, due to the sensible heat in the dry gases, of about one per cent. The condensation of the bulk of the moisture would reduce the moisture loss to a negligible figure. The use of oil for fuel should practically eliminate the "grate" loss, while the radiation loss, in view of the low temperature of the casing, should not exceed two per cent. Totaling these estimated losses, and allowing two per cent for incomplete combustion, it seems, from the meager data available, that the apparent generator efficiency should be around ninety-five per cent, an extraordinary figure. Deducting six per cent for the power consumed by the motor-driven hydraulic feed pump, forced-draft fan and oil pump, the net efficiency might be about eighty-nine per cent. If actual measurements of evaporation, oil consumption and auxiliary power consumption give a result approaching this crude estimate, it must be ranked as an astonishing performance.

Assuming, for purposes of discussion, that this efficiency can be obtained, the fact must not be overlooked that a lower efficiency would normally result if the generator were fitted into a plant where bled steam was used to heat the feed water. Such an arrangement, by elevating the feed temperature, would necessarily cause a marked rise in flue temperature. Yet bleeder heating is ordinarily considered particularly desirable in high-pressure plants.

Several ways out of this may, however, be imagined. The increased flue losses might be partly recovered in an air heater. Again the bled steam itself might be used for air preheating, thus permitting the unheated condensate to pass directly to the generator. In view of these limitations and possibilities further developments will be awaited with interest.

The American people are prone to seize upon and blindly follow slogans. Just now the term "superpower" has struck a popular note and has resulted in a more or less erroneous public conception of the idea which is quite different from the engineering viewpoint. But even engineers might well pause in their quest for lowering the cost of producing the kilowatt-hour, to consider whether they are not centering their efforts too much upon one phase of the problem to the exclusion of another equally important phase. In his article in this week's issue on "Superpower Versus Coal Conservation," Mr. Douglas points out the desirability of also considering the importance of heating as a factor in more efficient utilization of the fuel. His argument is sound and warrants thoughtful study.



Practical Ideas *from* Practical Men

Machining Coupling Face with Rotor in Position

The illustration shows the method used recently in refacing the coupling on the generator end of a 2,000-kw. steam-turbine unit. The coupling face was out about ½ in. To dismantle the generator and place the rotor in the lathe was out of the question, as it would have necessitated considerable expense and delay.

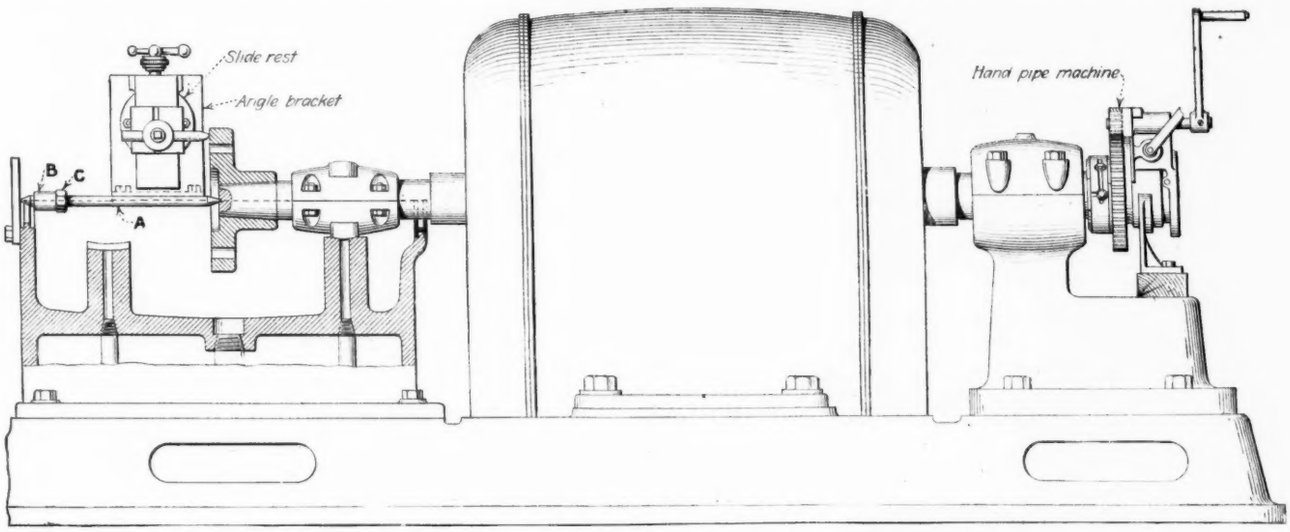
An angle bracket was bolted securely to the bearing casing, and a slide rest was mounted on it in a vertical position. The tool was fed vertically down the face of the coupling, the amount taken off the face being adjusted by tapping the tool in.

The end play was taken care of by a bolt *A* having a center point at one end, the adjusting nut *B* acting as the center at the other end. A piece of bar iron with a center on it was fastened to the end of the bearing casing and the bolt *A* adjusted by means of the nut *B* and locknut *C* so that no end play took place in the generator rotor.

At the outboard pedestal end the exciter armature was drawn off the shaft and a piece of key stock was inserted in the keyway. A hand-pipe screwing machine was placed over the end of the rotor shaft and blocked up to the desired height and securely bolted down, the dies acting as dogs with the assistance of the key stock made a secure drive.

The single-reduction gear made the starting rather hard, but once set in motion the speed of the rotor could easily be controlled by one man. The time required to face up the coupling, the diameter of which was approximately 15 in., was two hours and a most satisfactory job was made using this method.

New York City. H. T. MELLING.



Facing tool and land pipe machine in position for facing up coupling

Is Machine-Shop Training Essential for the Power-Plant Engineer?

It would be interesting to know by what route or process of evolution many successful engineers have attained the positions they now hold in the field of power-plant engineering.

The usual order of promotion to the position of operating engineer is by way of the boiler room, then the pipe and repair gang, and finally the engine room. It is important that the engineer should know boilers—how to get the most out of the coal. Yet if he attains the position of engineer by some route other than that of the boiler room, that is no reason why he should not be up on combustion.

Take the engineer who has had a thorough experience as a machinist. He is probably better posted on the mechanical side of engineering than the man who has not had this experience, and he has a decided advantage over the boiler-room bred engineer. Many engineers will likely not agree with this line of reasoning, contending that it is not required of the engineer to be able to turn out a good machine job. On the other hand, many will contend that machine-shop practice and power-plant practice go hand-in-hand and that a good knowledge of one is helpful to the other. How many

engineers operating today could go into the shop and turn down a worn pump rod that has been giving trouble, or perhaps turn out a bushing with a snug running fit?

It is the business of the engineer to install and maintain power-plant equipment, and he comes into intimate contact with repair jobs of almost every description. The man who has served his time as a machinist has learned through experience and daily working of metals their characteristics and peculiarities. That is, he knows the difference between grey and white cast iron, knows the different grades of steel, can differentiate between brass and bronze, and is not likely to recommend the making of a brass valve stem to replace a broken stem, which is usually of high-grade bronze.

The larger plants as a rule have their own machine shops, fully equipped to handle any kind of work that may arise, and employ a machinist or a number of them. The engineer in charge of the large plant of course would not be expected to do machine-shop work, but here again a thorough knowledge of metals is all to his advantage, for he should be able to direct the work from every angle.

Most small plants will have a machine shop (a drill press and a grinder), but without a lathe and shaper at least, the engineer is handicapped in trying to keep his plant in good condition. Lack of the means for doing repair work at the plant is reflected in the condition of the equipment. Sending the work out for repairs is costly and it is likely that the machine cannot be shut down for any great length of time. Hence the repair is not made until operating conditions are such that it is either repaired or replaced.

Many small plants will not install machine tools for the reason that there is no one about the place capable of using them. When the engineer is a machinist and could take care of machine-shop repairs, it would not take much talking to persuade the management to install equipment that would pay for itself with the savings effected. The engineer who is also a machinist is not only a valuable man to his employer, but his own field of work is considerably broadened by his knowledge of both subjects, which are so closely related.

Louisville, Ky. A. R. KNAPP.

Modification of Tester for Oils

There are two types of apparatus for determining the flash and fire points of lubricating oils, etc., the open and the closed.

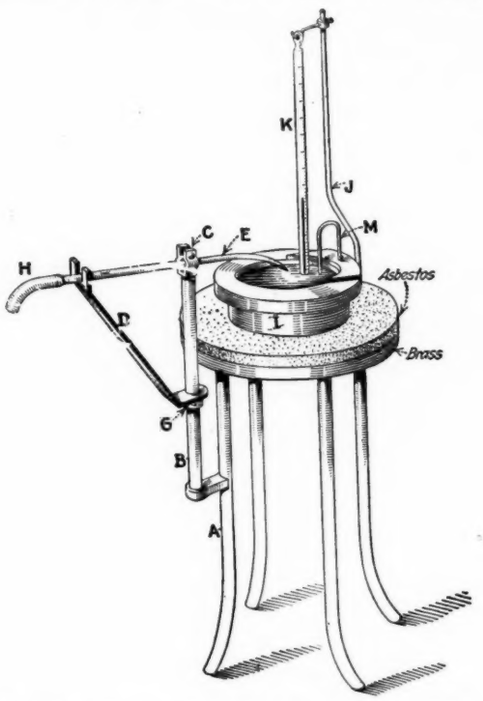
The results obtained with the closed cup are usually consistent provided the operator takes care of a few details such as the rate of the heating, the amount of oil in the container, the size of the test flame, etc. To check results with the "open cup" type of tester, even if the operator takes care of the points just mentioned, is extremely difficult. Test results obtained by the same operator on the same oil and with the same apparatus sometimes differ considerably, which is due mainly to the application of the test flame, which is not always moved through the mixture of gases and air above the surface of the oil at the proper place and speed.

About a year ago the writer modified the open-cup tester (see illustration). The modified apparatus has enabled the operator to check tests closely.

The oil cup *I* rests on a round solid plate, covered with a round asbestos plate having an opening large enough to hold the oil cup (A.S.T.M. Standard).

To one of the legs *A* is fastened a rod *B* which carries a small clamp *C* on the upper end wide enough to hold the bulb of the blowpipe *E*. The construction is such that the clamp can be turned freely. A bracket *D* is fastened to the blowpipe *E*, ending in a ring that fits around the rod. To hold the bracket in place a small shoulder *G* is screwed to the rod. Rubber tubing *H* supplying the gas is fastened to the blowpipe. The position of the blowpipe is adjusted so that the tip just clears the edge of the oil cup and sweeps across the center of the cup when moved.

A rod *J* is fastened to the brass plate to hold the thermometer *K* in place. The thermometer is suspended



Modified Tester for Flash and Fire Points

from a small clamp that can be used to adjust the proper height of the thermometer from the bottom of oil cup.

In order always to place the proper amount of oil in the cup for each test, a gage hook *M* is used. It consists of a metal base provided with a wire bent down so that its end will be at a definite distance below the upper edge of the cup. The cup is filled with the gage in place. When the surface of the oil strikes the end of the gage wire, the cup is known to be filled to the proper level. The gage is removed before the oil is heated.

The thermometer is suspended midway between the center and the edge of the cup. The oil is heated at a definite rate by a bunsen burner not shown in the cut.

When the test is made, the blowpipe *E* is swept over the cup in such a manner that the flame moves through the center of the oil cup. This is done at regular intervals as provided in the standard instructions for flash and fire tests. The flash point is the temperature at which the oil begins to flash, while the fire point is that at which it starts to burn continuously.

G. A. DE GRAAF, Chemical Division Chief,
Testing Laboratory, Public Service Electric Co.
Irvington, N. J.

Comments from Readers

Benson Generator Produces 3,200-lb. Steam in Test

During the week end of Feb. 17 the engineering staff of this company, under my direction and in the presence of a representative of Messrs. English Electric Co., Ltd., Willans Works, Rugby, carried out preliminary heat tests on the super-high-pressure Benson Generator which was fully described in *Power* of May 22 and 29, 1923. The principal features of the Benson Generator —that is, the method of steam generation at 3,200 lb. per sq.in., without ebullition, then throttling to 1,500 lb. and superheating—being now generally familiar to most engineers, it is not proposed to discuss the plant in detail, but to give some information regarding the results obtained.

It was considered advisable in the first place to have a covering insurance policy, and a representative of one of the leading insurance companies submitted the generator and pump discharge pipe to a hydraulic test pressure of 6,400 lb. per sq.in., for a period of 20 minutes. A special examination was made of the welds and joints, all being perfectly dry and with no signs of weakness anywhere. The hydraulic test, therefore, was entirely satisfactory, and the policy has been issued at a very low rate, in fact at a rate certainly not more than that for an ordinary boiler.

The object of the present tests being only to prove the theory of generating steam without ebullition and to demonstrate the efficiency of the plant and also to furnish data for the design of larger and more commercial units, the steam generator only was in operation and discharged directly to a surface condenser against a back-pressure valve which maintained a pressure in the superheater elements of about 1,500 lb.

The initial pressure in the generator heating elements was also maintained constant by a back-pressure valve between the generator and superheater, so that while the pressure in the generator was 3,200 lb., the actual pressure in the superheater was 1,500.

The first heat test took place on Sunday, Feb. 17, when the plant actually operated under its own oil burners for about four hours, the object of that particular run being only to tune up, thoroughly dry out the brickwork and to make the necessary adjustments. The temperature of the fluid was therefore intentionally limited to about 500 deg. F., the pressure of 3,200 lb. per sq.in. being maintained at all times.

A further heat test was carried out on the next day with the steam generator in commission about six hours. The final results were that a pressure of 3,250 lb. was maintained in the generator heating elements at a temperature of 725 deg. F. The fluid on being throttled to 1,500 lb. per sq.in. in the superheater, reduced the temperature to 620 deg. F., and the superheater elements raised the temperature at 1,500 lb. to an average temperature of 910 deg. F. Actually, at certain periods a temperature of 910 deg. F. was registered at the superheater outlet.

No apparent difficulties were experienced, and while of course it was not possible to ascertain visually the condition of the steam in the superheater, it was obviously highly superheated, the instruments at all times registering a steady reading, the evaporation during the test being over 8,000 lb. of water per hour.

While it is not intended at the present time to publish much information, an idea of the high efficiency obtained may be estimated from the fact that the temperature of the flue gases at the foot of the stack at no time exceeded 110 deg. F., the radiation losses being practically negligible, as the generator casing and the ducts to the stack were, by actual contact with the hand, only pleasantly warm. The result would appear to be one of the most remarkable features of the plant and demonstrates that the efficiency must be exceedingly high.

I would also like to add that the high-pressure joints gave no trouble whatever. They have never been adjusted since first being fitted into position. Regulation of the superheat with a constant evaporation was comparatively easy, and altogether the test exceeded all expectations.

W. A. JOHNSTON, Chief Engineer,
Benson Engineering Company, Ltd.
London, England.

American and European Hydraulic Turbine Practice

In the Feb. 19 issue, under "Comments from Readers," you published a letter from the writer referring to the controversy that has arisen as the result of an editorial in your paper entitled "Both Have Much to Their Credit."

This editorial was inspired by a paper the writer read before the National Electric Light Association at its annual convention last June. I note with interest the remarks signed "Editor," from which I will quote the following in regard to the Keokuk Plant:

> None of the designs that were considered was satisfactory, so that the power company called in an eminent Swiss engineer and with his assistance the general design for a single-runner turbine was worked out and given to two American turbine manufacturing companies to work out the details and build the turbines.

I wish to advise that this statement is incorrect in every sense. The design of the Keokuk turbines was a composite design decided upon by Col. Hugh L. Cooper, Chester W. Larner, of the Wellman-Seaver-Morgan Co., and the writer, representing the I. P. Morris Co. In comparing the designs of the Wellman-Seaver-Morgan Co. and the I. P. Morris Co., there were certain features which Colonel Cooper preferred in each design and he asked Mr. Larner and the writer to prepare a composite design which would embody what he considered to be the best features of each; and the contract for the turbines was awarded to the two companies mentioned on the basis of this composite design.

The mention in your editorial of a Swiss engineer

probably has reference to a former engineer of Escher-Wyss & Co., of Zurich, who was consulted in connection with the governors. He designed and built a few of the governors of the plant, none of which proved satisfactory and all of which were immediately discarded and replaced, this engineer's services being then terminated. Every feature of the final turbine design was derived without exception from either one or the other of the designs of the two American manufacturers mentioned and the foreign engineer referred to took no part in the preparation of this design. The design actually used was entirely and completely American in every sense. All of the foregoing is a matter of record.

To clear up the entire situation, it would be fitting to publish this letter, since the statement presented in the editorial tends to misrepresent the facts and to take from American manufacturers and engineers the credit which belongs to them for carrying out what was at the time the largest turbine installation which had ever been undertaken. H. BIRCHARD TAYLOR, Vice Pres.,
Wm. Cramp & Sons Ship & Engine Building Co.
Philadelphia, Pa.

The Throttling Calorimeter

The throttling calorimeter described by T. M. Gunn, in the Dec. 25 issue is an extremely simplified type. The main difference between it and the usual type lies probably in the fact that the wiredrawing of the steam is made through the throttle valve, while in the usual type it is made through a very small orifice in a diaphragm between the high-pressure and the low-pressure chambers. May I be permitted to point out that this is not a matter wholly negligible and that the values of moisture so calculated are likely to be overestimated?

When the wiredrawing is made through a very small orifice, the mass of steam that is allowed to flow is little and the steam velocity before and after the orifice is low. These velocities are of course different, even if the areas allowed for the flow of the steam are equal, as the specific volume after throttling is many times greater than before, according to the original pressure of the steam, and so there is an increment in the kinetic energy of the flowing mass, which is obtained at the expense of the heat of the steam. With the small hole of the usual diaphragm this increment of kinetic energy is negligible, with the throttle valve it is not wholly so.

Indeed, there can be, through the calorimeter, any value of the residual velocity according to the opening of the throttle valve. Let us suppose it is 200 ft. per sec. and that before the throttle valve 20 ft. per sec. The increment of kinetic energy per pound of steam is $\frac{200^2 - 20^2}{2 \times 32.2} = 614$ ft.-lb.; that is, about 0.78 B.t.u. per pound of steam which are expended raising the velocity of the steam instead of superheating it. Expressing this in terms of temperature, the superheat is about 1.6 deg. F. less than it should be, and I do not believe one would be disposed to accept an error of whole degrees in the reading of the thermometer. True, it takes about 20 deg. to make a difference of 1 per cent in the moisture, but even so we are not sure of the second significant figure in the expression of the moisture.

There is another consequence of this fact that is deprecable. As it lowers the degree of superheat in the low-pressure chamber, it narrows the field, already much restricted, where this sort of calorimeter is dependable for the measurement of dryness in the steam.

Naples, Italy. Prof. P. E. BRUNELLI.

In the Jan. 29 issue Ernest H. Peabody, in commenting on an article by Thomas M. Gunn in the Dec. 25 issue on "The Throttling Calorimeter," says in part: "I note also that Mr. Gunn finds a little difficulty in applying the word 'calorimeter' to an instrument that measures the amount of moisture in the steam, or in other words, to determine the steam quality." This statement seems to me somewhat unfair, since the application of the word by Mr. Gunn had no connection with the foregoing, his explanation reading, "In general the word 'calorimeter' is used to describe an instrument by which the content of heat in some substance may be measured." Then, in his mention of the steam calorimeter he says: "In a sense this is also true of the steam calorimeter, although it is generally understood that the steam calorimeter is intended for the purpose of measuring the amount of moisture in the steam, or in other words, to determine the steam quality." The first part of this statement by Mr. Gunn, and omitted by Mr. Peabody, applies the word in the proper sense. Further, Mr. Peabody does not offer any new explanation, but follows with the statement that too many people forget that the words "saturated steam" mean steam saturated with heat, not with water. Can anyone imagine steam as saturated with water? Applying the word saturated with all meaning, I fail to see how anyone could get this impression as Mr. Peabody states he found prevalent among young men he had talked with, since steam and water are of one substance in different forms, and also saturated steam is spoken of as being "wet" or "dry." I would like to see Mr. Peabody's application of the word "calorimeter" as applied to the steam calorimeter, in difference to Mr. Gunn's full explanation, which clearly implies that it is used in an indirect manner to determine the steam quality by directly measuring the heat content, unless he takes exception to the words, "in a sense"; which are followed with an explanation of the purpose for which it is used. J. J. ESSON.

St. John, N. B., Canada.

Methods of Securing Elevator Cables in Clamps or Sockets

In reference to the articles appearing recently in *Power* on the life of elevator cables, the following discussion may be of interest, especially since the method of putting the sockets on the cables may have a marked effect upon a cable's life. Some cable manufacturers advocate, but do not insist upon, the use of zinc for filling in the bell sockets. These recommend that the cable be served for two or three inches from the end with three or four turns of a single wire, the ends then flared and straightened, the hemp core cut out as far down as the serving, the ends cleaned with acid, and the acid then carefully removed, after which the socket is put into place and the zinc heated and poured. Fig. 1 shows three steps in this method. The objection to this process is that it requires a great deal more time than the babbitting plan, and unless the acid is carefully removed, dangerous corrosive action is likely to take place. It is probably safer to adopt the following plan:

First, place the socket on the cable; then serve with

wire for four to six inches from the end, depending on the length of socket; untwist the strands, but do not untwist the wires in the strands; remove the hemp core, and bend the ends of each strand outward, forming a loop, as in Fig. 2; then with each end of each strand pressed into the socket, pour molten babbitt to fill up the remaining space in the bell. This plan does not present the possibility of injuring each small wire, nor is corrosive-acid action possible, since no acid is required, it being unnecessary to use acid to cleanse the oil from the cable when babbitt is used.

During the course of the public hearing held in San Francisco on April 27-28, 1916, when the Tentative Elevator Safety Orders were openly discussed, a question was raised as to the most desirable method of fastening elevator cables to the car sling. Owing to the absence of any conclusive data on cable fastenings, the Industrial Accident Commission of the State of California conducted a series of tests. In preparing specimens for the tests, particular attention was given to the temperature of the zinc and babbitt, as well as the procedure in turning in, turning out, and straight methods of fastening. Babbitt was poured at a temperature that caused a small pine stick to char when dipped into the molten metal. Zinc, owing to its higher melting point, was heated just to that temperature where the stick, in addition to charring, would burst into flame.

The results of the tests indicated no great advantage in selection of sockets or thimbles for the straight method. However, certain types of closed sockets are not sufficiently recessed to contain a reasonable quantity of metal, with the result that several sockets when split with a hacksaw, showed a number of wires that had not come in contact with the spelter, which would indicate that a larger recess is essential. The turned-out method, Fig. 2, considered inferior to the turned-in method,

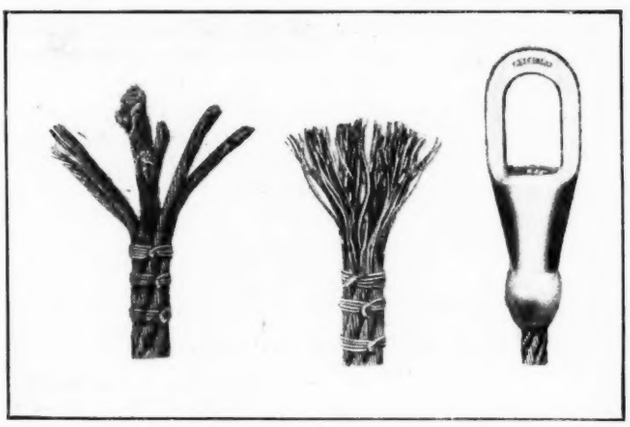


Fig. 1—Straight method of placing sockets on elevator cables.

Fig. 3, gave fairly satisfactory results. If comparison is made of the behavior of the loads as applied inside the fasteners, it is clearly seen why the turned-out method is preferable.

Assume that one strand is made fast according to the turned-in method. This strand as it enters the thimble is turned at an angle and then bent in. The load is therefore eccentric, whereas in the turned-out method the strand would not be turned until it had passed at least 1½ in. into the socket and at that point the spelter would have it firmly locked. This load would be applied straight to the point of bending.

There is a marked difference between the straight method (Fig. 1) results and those of other methods of fastening, which would indicate the desirability of the straight method over the others provided it is carefully prepared. The turned-in and turned-out methods have proved fairly successful, and while the straight method appears to be the most desirable, the matter of personal element would have a tendency to enter in,

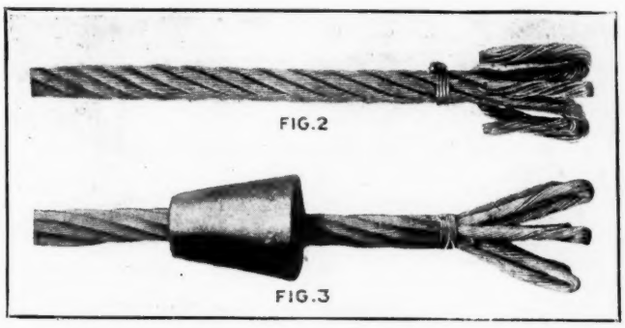


Fig. 2—Bent-out method of socketing cables
Fig. 3—Bent-in method of socketing cables

and in all probability result in a poor application of this method.

Particular attention was given to the behavior of the spelter inside of the fasteners. It was found in many cases that the babbitt or zinc had chilled before flowing to the small end of the fasteners and before completely covering the wires adjacent to the shell. It is needless to say that heating of fasteners is highly desirable before pouring the metal.

Another particularly noticeable feature was that none of the turned-in or turned-out fastenings developed anywhere near the full breaking strength of the cable. Furthermore, in these methods all cables parted inside the socket, averaging about one inch from the apex, in other words, usually where the heart had been cut out of the cable. There appear to be several reasons to account for this. Apparently, the hot metal has an injurious effect on the cables. In the turned-in and turned-out methods, it is impossible to arrange the strands and wires inside the fastenings in such a way that the load will be evenly distributed on each strand or wire.

The straight method tests, however, behaved much differently. In three of these tests the cables parted between fastenings, and in no case was there evidence of one strand giving way before the others.

Another conclusion drawn from the results was that it is essential that the length of all sockets be at least four times the diameter of the cable. For instance, several small sockets 2¼ in. in length were found to be too small to contain properly the 8-strand cables and the metal necessary to hold these strands intact.

Another thing to keep in mind when putting cables on elevators, is not to install one new cable to work with one or more old ones. Within a few weeks after installation, the new one may stretch as much as two feet, in some cases more, and it will not carry its share of the load. It is not possible to follow up the stretch with the shackle or with a turnbuckle.

WARREN HILLEARY, Supt.,
New York City. The Royal Indemnity Co.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Alternating-Current Generator Rating

If an alternator is rated at 175 kva., what kilowatt load is it good for at 80 per cent power factor? *H. S. P.*

The alternator will supply a kilowatt load equal to its kva. rating times the power factor. In this question $175 \times 0.80 = 140$ kilowatts.

Speed for Boiler Feed Pump

What is the greatest speed at which a 6x4x6-in. duplex boiler-feed pump should be operated? *F. C. H.*

For the valves to seat properly, the pump should not be operated at higher speed than 65 revolutions per minute, or 65 double strokes per minute of each side of the pump. However, to cover emergencies of low water in the boiler, the pump should not be relied upon as a boiler feeder for greater capacity than obtainable with one-half that speed, or 32½ double strokes per minute by each side of the pump.

Ratings of Motors and Engines

How do the commercial horsepower ratings of electric motors, of oil engines and of steam engines compare with their actual output? *D. A.*

The commercial ratings of electric motors and of oil engines are based on the actual or brake horsepower which they can develop when operated continuously. Steam engines are commercially rated in capacity according to the number of indicated horsepower which can be continuously developed by them with best economy, when supplied with steam of given pressure and quality, and exhausting against a stated pressure. The indicated power includes the power lost in friction, which varies from 10 to 20 per cent or more of the indicated power, and therefore the actual, or brake, power developed by a steam engine is something less than 90 per cent of the rated horsepower, according to the type, mechanical design, workmanship, lubrication and adjustment of the engine.

Racing of Shaft Governor Engine

What should be done to remedy racing of a shaft-governor engine? *W. M. N.*

If the engine simply speeds up and must be checked on the throttle, the trouble is due to excessive friction in some of the parts or the spring force of the governor is too great. Examine all governor pins and see that they are kept in good order and frequently lubricated. If the engine races or "bunts," rapidly changing speed within a given range, the trouble usually can be remedied by giving less tension on the springs and changing the weights to obtain the right speed. When the racing is due to spring tension only, the changes of speed will be rapid and even. But when caused by friction, the weights will stick on their inner position until the speed becomes so high that the weights are thrown out with a noise; or when the engine is above speed, the weights may stick where they are until the speed is sufficiently reduced for the spring to draw the weights back again.

Cooling Water Required for Jet Condenser

How many pounds of cooling water would be necessary to condense one pound of steam, having barometer 29.9 in., vacuum 26 in., and temperature of injection water 65 deg. F.? *N. R. D.*

The temperature of steam corresponding to an absolute pressure of 26 in. vacuum, or $29.9 - 26 = 3.9$ in. of mercury, is 125 deg. F. But the discharge temperature must be lower than this as the pressure in the condenser is due not only to the aqueous vapor, but also to that of the air carried over with the condensed steam and circulating water, and the discharge temperature will be from 10 to 15 deg. lower than the temperature corresponding to the vacuum shown by the gage. Assuming 15 deg. lower would make the discharge temperature 110 deg. F. As may be found from tables of properties of steam, the total heat of a pound of steam at the absolute pressure of 3.9 in. of mercury is 1,114 B.t.u. above 32 and, when condensed to water at 110 deg. F., the heat absorbed per pound of steam would be $1{,}114 + 32 - 110 = 1{,}036$ B.t.u.; and as each pound of water would absorb $110 - 65 = 45$ B.t.u., theoretically the condensing water required per pound of steam would be $1{,}036 \div 45 = 23$ lb. On account of the inefficient heat absorption in practical installation, 5 to 15 per cent must be added to this theoretical weight of cooling water.

Evaporating Water with Exhaust Steam

At what temperature can water be evaporated by exhaust steam? *L. C.*

The temperature at which vaporization or boiling takes place within the body of the liquid, commonly called the boiling point, is the same as the temperature of saturated steam at the same pressure. The pressure of the atmosphere at sea level is 14.7 lb. per sq.in. absolute, and at that pressure the temperature of saturated steam is 212 deg. F. The pressure of exhaust steam of a non-condensing engine is necessarily somewhat greater than the pressure of the atmosphere, and the temperature of the exhaust is higher than 212 deg. F. Therefore by imparting enough heat of the exhaust to water that is at atmospheric pressure, its temperature can be raised to 212 deg. F. But if the pressure on

the water is no more that the pressure of the atmosphere, the temperature of the water cannot be raised any higher than 212 deg. F., since as fast as heat may be received by the water it will be absorbed by the process of vaporization. But if the pressure on the water is more than the pressure of the atmosphere, the water would be evaporated at the temperature of saturated steam of the same pressure, provided the temperature of the exhaust at the place where heat is transferred to the water is higher than the temperature of saturated steam at the pressure of the water and there is enough exhaust steam for the purpose.

Changing R.-T. Boilers from Coal to Oil Burning

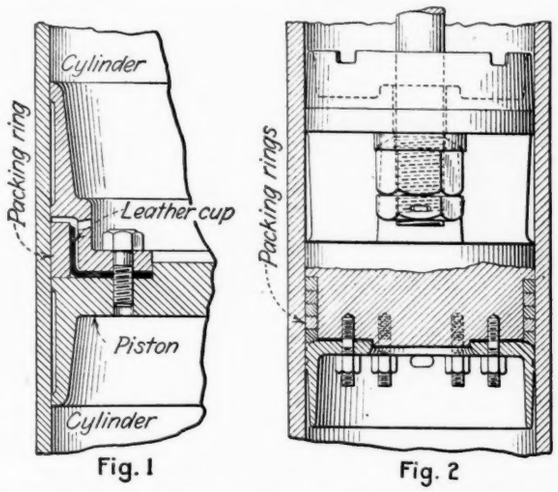
What equipment and alterations are necessary to change a horizontal return-tubular boiler plant from hand firing of coal to oil burning? *W. A. M.*

For oil burning the principal equipment required consists of oil storage tanks, oil pumps, oil heaters, oil burners, properly housed and protected from the heat with necessary interconnecting piping, strainers and regulating valves and, if desired, an automatic oil-control system may be installed. Where the boilers are equipped for hand firing of coal, the furnace can be adapted to oil burning by covering the grates with firebrick to form a checkerwork floor with suitable openings for admission of air; but higher efficiency is obtained with a deeper furnace space than ordinarily provided above the grates of return-tubular boilers, by removing the coal grates and providing a firebrick checkerwork floor near the ashpit floor, with suitable openings and adjustable doors for admission of air below the furnace floor. In either case the bridge wall should be reduced to the level of the furnace floor and a checkerwork wall or staggered piers of firebrick should be placed in the back part of the combustion chamber about four feet forward of the blowoff connections, to insure more perfect mixing and combustion of the gases before they arrive in the rear connection for distribution to the fire tubes of the boiler.

Packing for Hydraulic Elevators

What kind of packing is used in the pistons and valves of hydraulic elevators? *W. H.*

On the older types of small vertical cylinders, up to 13½ in. in diameter, a cup leather and square packing were used as in Fig. 1. The flanges of the cup point upward in the cylinder. The square packing is placed in rings around the outside, so that the pressure acting on the cup leather causes the packing to be pressed outward toward the cylinder walls, thus insuring a tight fit. The pistons of modern and larger vertical cylinders do not have cup leathers, but are packed with square packing as in Fig. 2. Some pilot valves are packed with cup leathers, others being of solid construction operating without packing, except that some have an external gland through which the rod passes. The controlling valves are packed with leather cups. The automatics are solid valves operating without packing except that some stems have external packing gland, and except that on some types there is one cup leather which takes the place of a packing gland. There are a number of hydraulic elevators with controlling-valve stems operating through packing glands. After the packing in the gland has been in service for a short time, it loses its resilience, and the friction between the valve stem and the packing becomes so great as to cause uncertain action of the valve. The controlling valve should not be outside-packed. On horizontal-cylinder engines, the automatic valve stem is also sometimes of the outside-packed type. This is an objectionable feature, for, when the travel of the crosshead closes the automatic valve, as it should do at top and bottom terminals, the friction on the valve stem is often so great that the valve does not again open when the car leaves the terminal. This causes the car to travel very slowly until the automatic



Figs. 1 and 2—Show location of packing in pistons of hydraulic elevators

mechanism is moved into the open position by hand. A particular, and worse, objection to the device is that after the car leaves a terminal, the valve, owing to friction, may remain in the closed position until the car has traveled a few feet. Then pressure in the system may overcome the friction, whence the automatic valve will open suddenly, causing the car to increase speed so rapidly as to be dangerous.

Time Required for Freezing Can Ice

What would be the freezing time for can ice with brine temperatures ranging from 9 to 20 deg. F.? *J. F. D.*

The table gives the hours required to freeze ice in cans of different thicknesses with brine at varying temperatures, based on experiment of Gardner Vorhees, refrigerating engineer. There will be a slight variation by reason of the different temperatures at which the water is placed in the cans.

HOURS REQUIRED TO FREEZE CAN ICE

Brine Temp. Deg. F.	Can Thickness, Inches										
	3	4	5	6	7	8	9	10	10½	11	11½
6	2.4	4.2	7.0	9.6	12.2	17.0	21.7	26.7	29.4	32.4	35.3
7	2.45	4.3	7.2	9.9	12.6	17.5	22.3	27.5	30.2	33.3	36.4
8	2.5	4.5	7.5	10.3	13	18.3	23.2	28.6	31.5	34.7	37.8
9	2.6	4.7	7.8	10.6	13.6	18.9	24.0	29.7	32.7	36.1	39.4
10	2.7	4.9	8.2	11.2	14.3	20.0	25.4	31.25	34.4	37.9	41.4
11	2.9	5.1	8.5	11.7	14.9	20.9	26.5	32.5	35.9	39.6	43.2
12	3.0	5.4	9.0	12.3	15.7	21.9	27.9	34.3	36.8	41.7	45.4
13	3.2	5.7	9.5	13.0	16.6	23.0	29.3	36.1	39.7	43.8	47.8
14	3.4	6.0	10.0	13.7	17.5	24.4	32.1	38.2	42.0	46.3	50.5
15	3.6	6.3	10.5	14.4	18.4	25.6	32.5	40.1	44.1	48.6	53.0
16	3.7	6.6	11.0	15.0	19.3	26.8	34.0	42.0	46.2	50.9	55.5
17	4.0	7.2	12.0	16.4	21.0	29.3	37.2	45.8	50.4	55.5	60.6
18	4.3	7.4	12.8	17.8	22.4	31.2	39.7	48.9	53.8	59.3	64.6
19	4.7	8.3	13.8	18.9	24.2	33.8	42.9	52.6	58.2	64.1	68.9
20	5.1	9.0	15.0	20.5	26.2	36.6	46.5	57.3	61.0	69.4	75.7

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Here and There in the Power Plant

Sidelights on things generally used but less generally understood

The Suction Side of the Pump

By William V. Fitzgerald

FEW people, even those dealing with the pumping of liquids every day, realize that the pump employed for the purpose of moving the liquid is utterly dependent upon the force of gravity for its success.

Where working with a suction lift the pump is situated above the surface of the liquid. Gravity, through the weight of the atmosphere, is exerting a pressure of 14.7 lb. per sq.in. (at sea level) on the surface of the liquid. The function of the pump in this case is merely to relieve the pressure of the air at some particular point in order to permit the water to rise at that point.

But it should be kept in mind that the water would never follow the piston on the suction stroke were it not compelled to do so by some outside force. In this case that force is gravity acting indirectly through the atmosphere.

In the second case the force of gravity is exerted *directly* upon the liquid because the surface of the liquid is above the pump. Nevertheless, the force of gravity is equally present in both cases.

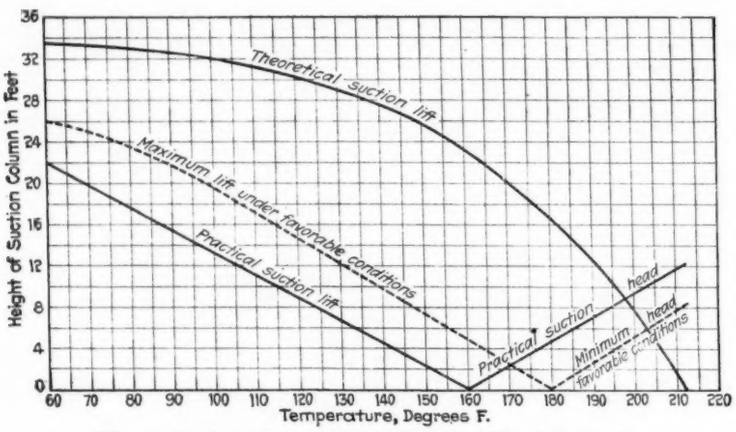
With the foregoing statement in mind, it is readily seen that the height of a suction pipe above the surface of the liquid to be pumped, cannot in any case be more than a distance corresponding to the pressure of the atmosphere, that is, a column of water weighing 14.7 lb. per sq.in.

This height is approximately 34 ft. This is easily figured. Assuming the column of air extending upward indefinitely to weigh 14.7 lb. for a column one inch square, a column of water that will balance the column of air is found by dividing 14.7 by 0.433, which gives a height of approximately 34 ft.

Assuming further that the pump has drawn the water to this height, the column of water and the column of air are in balance and the pump is powerless to raise the water any higher. The height of any column of liquid is of course dependent on the specific gravity of the liquid.

For example, mercury is many times heavier than water and can be raised to a height of only about thirty inches, as against nearly thirty-four feet for water. Other liquids range higher than water for the theoretical column.

The accompanying diagram brings into the story another factor that has not been considered—the temperature of the liquid. This is an important factor and one that is often considered too lightly where warm or hot water is handled.



Theoretical and practical suction lifts for water

Taking water at 60 deg. F., it is observed from the upper curve that the height of the theoretical column of water is nearly 34 ft. Looking over the 100-deg. division, it is observed that the theoretical column is reduced to 32 ft. At 150 deg. it is 26 ft. and at 180 deg. it is 17 ft. Finally, at 212 deg., the theoretical suction lift comes down to zero.

This lowering of the suction lift is due to the fact that liquids have a "vapor pressure" at ordinary temperatures. At low temperatures this effect is not marked with most liquids, but in all liquids it increases more and more rapidly as the temperature rises. At 100 deg., for example, the vapor pressure of water has been determined as 0.946 lb. per sq.in. Therefore, in determining the theoretical height for this temperature, it is first necessary to deduct this pressure from the atmospheric pressure of 14.7 lb. per sq.in., which results in a shorter column. As the temperature of the water rises, the vapor pressure is increased until at 212 deg. the vapor pressure of the water becomes equal to the pressure of the atmosphere upon it and the suction column is zero. A pump is therefore powerless to handle water by suction at this temperature.

Leaving the theoretical and turning to the practical phases of suction, the diagram shows that the actual practical suction lift is much lower than the theoretical lift, and instead of being able to handle water efficiently at 60 deg. to a height of nearly 34 ft., a height of only 22 ft. is practical. This curve runs roughly parallel to the theoretical curve, but reaches the zero line at 160 deg. At 160 deg., therefore, the pump will work satisfactorily only when the level of the pump suction is coincident with the level of the liquid to be pumped.

The line of practical suction lift ceases at 160 deg. and becomes a rising line which is called the "suction *head*." This is because at temperatures above 160 deg., the pump will not work unless the water flows to the pump under a head of several feet according to the temperature. Thus, for a boiler-feed pump located between the feed-water heater and the boiler, to work to the best advantage, it is necessary to have the pump suction about 12 ft. below the surface of the liquid to be pumped. Although boiler-feed pumps may work with less suction head than indicated on the chart, it is not advisable, and the best results will not be obtained by such practice.

A common error that is often made is to regard all liquids as governed by the same conditions as water. The particular liquid that is to be handled in any pump job should be considered for three things: The temperature at which the liquid is to be handled, the vapor pressure at that temperature and the weight of the liquid per cubic foot.

With these data the theoretical suction lift can be figured in the manner already shown for water. Then a similar allowance may be made for practical conditions.

The action of the pressure side of the pump is dependent solely on the power of the pump and strength of the materials of which it is composed, and no limit can be placed on the height to which the pressure side of the pump will lift successfully.

The suction lift, on the other hand, is definitely limited to a figure that falls below 34 ft. (for water) by an amount depending mainly on the temperature of water with a practical allowance for such factors as friction in the suction line.

Fuel Oil or Coal for Steam Generation*

By F. H. DANIELS†

THE object of preparing this paper was to make a brief survey of the available supply of petroleum and coal in the United States, to show the rate at which these supplies are being used, and to compare the use of fuel oil with the burning of coal on modern mechanical stokers for steam generation.

According to figures of the United States Geological Survey the total oil production of the world up to 1923

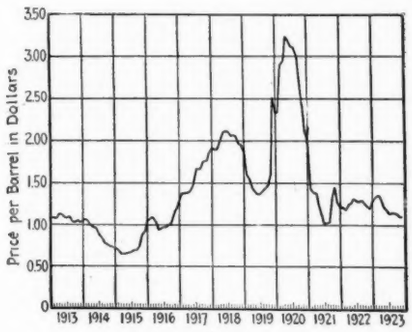


Fig. 1—Variation in boiler oil prices

has been about 8.5 billion barrels and the United States has furnished about two-thirds of this. The estimated reserves of the world have been set at approximately 43 billion barrels, of which this country is estimated to have 8½ billions. In 1922 the United States consumption was 592 million barrels, while the domestic production was 557 million, making an overconsumption of 6 per cent. The excess was made up by imports chiefly from Mexico. In 1923 the consumption was about 710 million barrels and production 726 million. This showed for 1923 an overproduction of about 4 per cent and is accounted for by the great flood of unexpected oil which came from the California and the Powell, Texas, fields. For example, California produced 80 per cent more oil in 1923 than in 1922. This condition has now been changed practically over night, and predictions are now being made that domestic production for 1924 will not exceed 675 million barrels.

Estimated Coal Supply

In reference to the available supply of coal the story is quite different from that of oil. We have still left about 1,510 billion tons of bituminous coal, having used less than 1 per cent of our original deposits. We have approximately 17 billion tons of anthracite still in the ground, having used about 15 per cent of our original supply, and there are also over 2,000 billion tons of lignite. This makes the grand total of 3,527 billion tons. A comparison of these figures shows that the ratio of the available coal heat units to the available oil heat units for this country is about 1,370 to 1.

There is one more fundamental difference between our reserves of coal and our available supply of oil. With coal, after a mine is discovered, it can either be taken out of the ground or left in the ground at the option of the mine owner. If the price of coal is high enough for profitable mining, it will be taken out of the ground. If the price is not high enough to show a good return, the coal can be left in the ground without any deterioration and without much cost except that of keeping the mine clear of water. In the case of oil, however, after a well is once drilled, the oil must be taken out. If the well turns out to be a gusher, there is nothing to do but to take the oil and sell it for what the market will give, since it is very expensive to store large amounts. If the well is not a gusher and pumping is to be resorted to, the owner is afraid not to pump because there is an ever-present danger of surrounding wells draining the pool of oil, thereby taking away from the well owner his one possibility of getting a return. In fact, the tendency is to pump the well as fast as possible, so that no one else may get the oil. Here again the oil must be put on the market promptly to avoid the expense incident to storing.

The arguments usually presented for and against oil are as shown below, and it is interesting to take these up one by one and consider them with the understanding that the coal is not to be hand-fired, but is to be burned by the use of mechanical stokers. The chief advantages of fuel oil are generally given as follows: (1) High efficiency; (2) high capacity; (3) low labor costs; (4) low first cost of equipment; (5) no smoke; (6) quick response to overload demands; (7) less storage space required than coal; (8) small amount of refuse; (9) no banking losses.

Under the best of test conditions fuel oil has shown over-all boiler efficiencies up to 82 per cent, and some tests show even above this. But the mechanical stoker can show equally good results and can beat oil efficiency if preheated air is used. It is then fair to assume that under average operating conditions the efficiency of furnaces using fuel oil will be no greater than that obtained with mechanical stokers burning coal of 12,500 B.t.u. and higher. Of course it must be remembered that there is good and poor fuel oil just the same as there is good and poor coal, although the range of heating value of coal is more than the range of heating value of fuel oil.

The multiple-retort underfeed stoker will show higher boiler capacities than any that can be obtained with fuel oil. Most tests on fuel oil have been in connection with boilers where the furnace volumes were restricted. There have been no tests published where fuel oil has been used in connection with a furnace large enough to enable the oil burners to show up to best advantage. It is safe to state, however, that with equal furnace volumes mechanical stokers will show higher capacities than are possible with oil.

Under proper conditions the mechanical stoker in large plants should not require more than one fireman and one water tender for each 50,000 sq.ft. of boiler-heating surface. It is impossible for a plant equipped with fuel oil to get along with a less number of men than this. As far as attending to the water level of the boilers is concerned, the labor involved is equal in each case, and the stoker does not require any more adjustment than would be needed for the manipulation of oil burners.

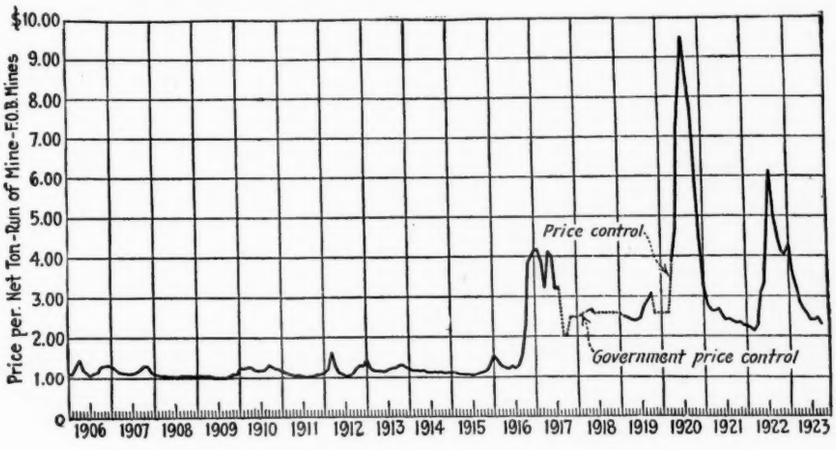


Fig. 2—Bituminous coal spot prices

Of course it must be admitted that the use of fuel oil practically eliminates the question of ash handling, but this is not a very serious factor because the labor required for handling the ashes in an up-to-date plant is not very large and the class of labor is the lowest paid.

On the comparative first cost of the two systems, the use of fuel oil avoids the necessity of the purchase of me-

*Extract of paper read before the New England Wholesale Coal Association, Feb. 13, at Boston, Mass.

†Vice-president, Sanford Riley Stoker Co.

chanical stokers and auxiliary equipment, which might range in cost from $0.80 to $1.40 per square foot of boiler-heating surface. The fuel oil also avoids the necessity of coal- and ash-handling equipment, which would cost from 60 to 80 cents per square foot of boiler-heating surface. This would make a total of about $1.80 per square foot of heating surface. As an offset to these items fuel oil requires storage tanks, oil pumps, heaters and burners, costing anywhere from $1 to $3 per square foot of boiler-heating surface, depending upon the amount of reserve oil that is to be kept in storage. For a central station having 50,000 sq.ft. of boiler surface, the complete oil-burning equipment with storage tanks for five months' supply of oil has been estimated at $250,000, which would be at the rate of $5 per square foot. An industrial plant could of course get along safely with much less than a five-months' supply of oil, but in almost any plant there will be little if any decrease in first cost in favor of fuel oil.

The air to the oil burners should be cut down for best economy so that a slight haze is emitted from the chimney. Any additional air will stop the smoke completely, but it will be in excess of the amount needed for combustion and will reduce the efficiency of operation. The mechanical stoker is every bit as good as oil burning as regards this feature of smoke.

Quick Steaming with Stokers

The underfeed stoker of today can raise a boiler from banked fire to 300 per cent of rating or more in from five to ten minutes. The plant with fuel oil cannot boast of any quicker response than this. The underfeed stoker can be shut down from high capacity almost as quickly and does not compare unfavorably with the oil burner with which it is merely necessary to stop the supply of fuel. In either case the heat stored up by the brickwork of the furnace is the limiting feature in time required to shut down a boiler.

For equal calorific values fuel oil will occupy only about two-thirds of the storage space required for coal. On board ship this is important, but on land the coal can be stored in one continuous pile in the open, while oil must be kept in tanks properly spaced from one another. Under these conditions the land occupied for the storage of fuel oil would amount to as much as that required for storing an equal calorific value of coal.

While it is true that the burning of fuel oil leaves no ashes to be disposed of, there is the question of the residue that is deposited on the heating surface of the boiler. This residue is oily and is highly non-conductive. In order to remove the oil residue from the tubes, it is necessary to use steam soot blowers four or five times a day. This is more often than is necessary to remove the soot from coal-fired boiler tubes and results in an extra loss of steam.

In the case of a plant where the load factor is low, there is claimed to be a considerable saving due to the fact that there are no banking losses. In the case of a stoker the coal consumption on a banked fire is approximately 30,000 B.t.u. or 2.15 lb. of coal per square foot of grate surface per hour. If we consider a 5,000-sq.ft. boiler with a grate surface of 80 sq.ft., the coal used per hour would amount to 172 lb. This banking loss is offset by the additional steam that the oil burners using steam require over that used by the mechanical stokers. This additional steam would amount to about 3 or 4 per cent of the boiler output.

Fig. 1 shows the average price of fuel oil in the United States for the last ten years. The low point was in 1915 at about $0.65 per barrel. The high came during the period of inflation after the war in 1920 rising to $3.24 a barrel. This represents an increase of 400 per cent above the low figure. The low price in 1919 was due to the releasing of fuel oil that had been held for war purposes by the Navy. Another low point came during the panic of 1921.

Fig. 2 shows the variations in the average spot price of bituminous coal f.o.b. mines from 1906 up to 1924. The price ran along very steady at about $1.25 per ton until just before the United States entered the war. Then government price control was in force during and for a period after the war. The strike of November, 1919, sent spot prices up to $9.51 per ton in the middle of 1920. After the strike, coal dropped to about $2.25 and then jumped up to $6.10 on account of the strike of 1922. It is clear from the curve that, except for the strikes, spot coal would have been about $2.50 per ton for the period after the war which would represent, roughly, twice the pre-war price.

Most of the fuel oil used under boilers comes from California, Texan and Mexican fields. The history of Mexico for the last ten years should be a good criterion for the possibility of interruption of supply in case any large number of steam-generating stations adopt oil as their regular fuel. The Southern fields can supply but a small percentage of the fuel oil that would be needed in case it was generally adopted.

Must Consider Future of Supply

There is one aspect of the fuel-oil problem that is generally overlooked by the prospective user. It should be remembered that the only safe way is to figure that the fuel savings must be sufficiently large to amortize the first cost of the necessary oil-burning equipment during the term of the fuel-oil contract. If this amortization factor had been more carefully considered, many oil-burning plants would never have been started up.

To sum up the whole question, it is quite clear that fuel oil cannot compete with coal for the generation of steam in land plants, except for the short periods of time when overproduction gluts the oil markets or when strike conditions upset coal production. The figures showing the relative reserves of coal and oil in the ratio of 1,370 to 1 make it quite clear also that the short periods when oil has the advantage will in the future become less and less frequent and of shorter duration. The year 1924 looks like decreased oil production and increased prices.

Refrigeration in the Manufacture of Gasoline

By H. J. Macintire

It is not generally known that refrigeration is a factor in the production of gasoline. There is no definite compound called gasoline, but the term is applied to a number of hydrocarbons, such as propane, butane, hexane, nonane, etc., including a little ethane, all mixed or dissolved together. The separation of these hydrocarbon compounds from either casing-head gas or natural gas by the means of refrigeration may be carried out by either of two methods.

First there is the method by which the gas is compressed to 160 lb. or more and then is allowed to throttle or to expand in an expansion cylinder of the compressor engine. The temperature is lowered in either of these processes, but much lower in the case of the expansion cylinder, and the gasoline fractions are condensed out during the fall of the temperature. Casing-head gas is gas coming from producing oil wells, being that portion of the petroleum that vaporizes at the reduced pressure in the well. The raw casing-head gas emanating is forced by pumps to a central point, at which it is picked up by a compressor and compressed to a pressure varying from 5 to 40 lb. or even more. The compressed gas passes through a series of water-cooled atmospheric condensers, during which process the heavier gasoline fractions contained in the gas are condensed and collected in an accumulator tower 30 to 90 ft. high filled with tile or other special devices manufactured for the purpose. An absorbent oil introduced at the top flows down in a thin film state and, coming into contact with the upward passing gas, absorbs the gasoline content in the gas. This oil passes from the bottom of the tower into the heat exchanger, thence to the pump, which forces it through some water-cooled atmospheric coils, thence into a still where the gasoline content is driven off by heat. The denuded oil then passes into the heat exchanger, thence to a pump which forces it through some water-cooled atmospheric coils, and finally to the top of the tower, thus completing the cycle. In the case of natural gas the conditions are the same practically, except for the characteristics of the gas.

In the absorption process, to obtain the maximum efficiency of extraction, it is necessary to pump a large amount of oil through the tower. This results in a low saturation of the mineral seal oil, a large capacity heat exchanger, a large still and a large pump. Even then it is sometimes impossible to extract the entire gasoline content of the gas in summer. This is particularly true of plants treating so-called dry or natural gas containing from 0.1 to 0.5 gal. per 1,000 cu.ft. of gas.

In these plants it has been found necessary to use refrigeration to cool the oil down to the temperature at which the vapor tension of the gasoline content of the gas is sufficiently overcome to cause its condensation and absorp-

tion by the mineral seal oil. Also, in the operation of absorption plants the lighter and more volatile gasoline fractions are not condensed as they are driven from the still, but pass through with what condensate does form in the absorption accumulator tank, from which point they are withdrawn by a compressor which compresses them up to 80 to 100 lb. After leaving this compressor, they pass through a series of water-sprayed atmospheric condenser coils where they are condensed and separated from the entrained methane and ethane.

It has been found that gasoline produced in an absorption plant does not need blending, the vapor pressure being low enough so as to allow it to be shipped just as it comes from the still. At some plants gas compressors are used to treat the uncondensed still vapors which come through the cooling coils and make rather a "wild" gasoline of the same characteristics as that produced by other compression plants. This product is often blended with still-run gasoline. Other plants treat the uncondensed still vapors in a secondary absorption tower, using mineral seal or naphtha as the absorbent. In the case that mineral seal oil is used, it is sent to the still. If naphtha is used, the product is sent to market as it comes from the absorption tower.

The refrigerating machine therefore has its place in gasoline production, although it is not used universally nor is it of equal advantage in every case.

Corrected Standards for Pipe Fittings at Higher Pressures and Temperatures

Certain changes have been made in the proposed pipe-flange standards as published in the Dec. 4, 1923, issue. These corrections, as given in the table, were made subsequent to publication of this article, which stated that the published data were subject to later alterations. The standards are now awaiting confirmation by a letter ballot vote of the Sectional Committee. The procedure, as described on page 776 of the Nov. 13, 1923, issue, is required for their adoption as tentative American Standards.

TENTATIVE STEEL FLANGE STANDARDS

Nominal Pipe Size	I. D. of Fitting	Minimum Metal Thickness of Fitting	Bolt Circle	Minimum Thickness of Flange	C. to F. of Elbow Tee and Cross	F. to F. of Reducer
		American 250-lb. W.S.P.				
5						
		American 400-*lb. W.S.P.*				
3½			7¼			
18 O.D.						19
		American 600-*lb. W.S.P.*				
3½			7¼			
16 O.D.				3		
		American 900-*lb. W.S.P.*				
1					4½	
1¼					5¼	5¼
1½					5½	5½
6						11½
12 O.D.				3½	18½	
14 O.D.	12¼			3½	20	
15 O.D.				3 7/16	21	
16 O.D.				3½	22	

Refractory Linings for Furnaces*

By J. C. Martin, Jr.

In the selection of the refractory, particularly with relation to the clays available for use in the Pacific-Coast section, the principal qualities required are resistance to spalling due to the flame play of oil-fired furnaces at heavy loads. To understand the full significance and seriousness of this, it may be said that spalling in an oil-burning furnace is usually the first sign of failure in the refractory lining by reason of the brick itself.

It usually occurs in a well-defined way. First, a thin section of the brick scales off and drops into the flame way, being followed by a glazing over or vitrifying of the surface exposed by the spall. This new surface remains intact until spalling again occurs. A repetition of the spalling continues, with a new thinner refractory surface exposed to the flame each time, until the brick finally gives way by physical weakness or lack of material to sustain it.

Susceptibility to spalling is a condition set up within the brick during the course of manufacture. It is real economy to pay a little more for a refractory produced by methods and clay mixes that will overcome spalling to the greatest possible extent, if not entirely. The increased cost is negligible compared to the efficiency in service.

Another essential quality is good structure. A brick well bonded together which will be capable of compensating expansion and contraction without increasing the spalling condition, and which will not readily absorb water by being too open or porous. A further needed quality is the ability to withstand the scouring effect of flame play, to assimilate and discharge heat and not to soften at maximum firebox temperatures. The ability of a brick to become radiant as quickly as possible is of material advantage. In firing up, the sooner the brickwork becomes hot, the less drippage of oil from the burner results, all the oil being flashed into a clean flame.

The installation of the refractory is very important. In laying, so far as possible, the bricks should have a bearing hard against each other, with the thinnest possible joint between them. Too much stress cannot be laid upon the point that thick mortar joints between the brick are a sure cause of failure, and that the first break in the setting itself occurs through the weakness of the heavy mortar joint, either through temperatures causing it to run out of the joints or settling causing a break in the heavy joints used.

The jointing should be made of material of relatively the same quality as the refractory itself. Primarily, the function of a jointing material is to seal the joint to prevent flame licking between the open or uneven faces of the brick as they rest on each other and to prevent air leakage into the firebox. The thinner the joint can be made and accomplish these purposes, the longer the lining will remain intact.

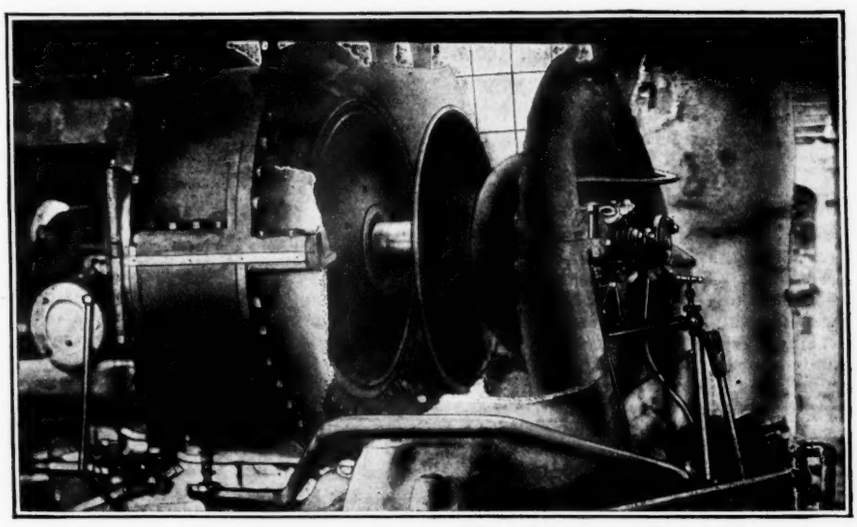
*Abstract of talk recently given at the Engineers Club in San Francisco.

Turbine Explodes While Carrying Load

No abnormal circumstances have so far been found responsible for the failure of a 3,650-kw. 3,600-r.p.m. turbine at the station of the St. Cloud Public Service Co., St. Cloud, Minn., on Feb. 5. The information available indicates that the machine was in regular operation when the accident occurred, and had not been subjected to any unusual disturbance previously. The third-stage wheel fractured and left the shaft completely, as shown in the figure.

Preliminary investigation has revealed no positive reason for the disk failure, according to reports.

Outside of the wrecked unit little damage was produced. Fragments of the machine slightly damaged the switchboard. Parts of the rotor punctured the roof and one of the steel stacks. An operator sustained a slight injury.



Third-stage wheel fractured through hub

Recent Publications

"Mechanical World" Electrical Pocket Book. Published by Emmott & Co., Ltd., Manchester, England. Cloth; 4x6 in.; 387 pages; 141 illustrations. Price, 50 cents.

This book is a collection of practical electrical notes, rules and tables and has been revised to bring it up to date. Although the book deals with a great variety of electrical subjects, a considerable part is devoted to motors and generators. Troubles in direct-current motors and generators have been tabulated in a handy table. Among the other useful tables in the book are those on the horsepower of motors to drive machinery; current-carrying capacity of insulated wire; horsepower of leather belts and of rope drives. The book is essentially British in the practice treated of, but much of the information will be found applicable to electrical equipment in general.

Elementary Hydraulics. By F. W. Medugh, Instructor in Civil Engineering, The Johns Hopkins University. Published by D. Van Nostrand Co., New York City. Cloth 5x8 in.; 144 pages; 71 illustrations; Price $2.

Although primarily designed as a textbook, this work is a handy volume for perusal by engineers who may desire to review the elementary principles involved in the solution of hydraulic problems of every-day experience. The work is subdivided into chapters, which explain pressure on surfaces, pressure on immersed and floating bodies, measurement of pressure, flow through pipes of uniform section, friction loss in pipes, flow through pipes of non-uniform section, the Venturi meter, effect on flow of changes in direction and the Pitot tube. Separate chapters are also given on the subjects of orifices, weirs, short tubes and nozzles, flow in open channels and hydrodynamics of an impinging jet. Most of the figures are diagrammatic and well illustrative of the text, and formulas are stated in the simplest mathematical terms compatible with the subject.

Alternating-Current Armature Winding. By Terrell Croft. Published by the McGraw-Hill Book Co., Inc., New York, 1924. Cloth; 5½x8 in.; 352 pages; 326 illustrations. Price $3.

This book presents a practical treatment on the winding of alternating-current machinery stators. No attempt has been made to include an elaborate discussion on winding design, but the text has been devoted to those problems that the electrician and armature winder may be confronted with. The object throughout the work has been to present the subject matter with illustrations, using a minimum of text. Necessary problems have been worked out to assist the reader in the application of the various principles involved in the different types of winding.

The book is divided into six divisions. In division 1, armature-winding, classifications, definitions and types of windings are treated. How to rewind a machine for the same condition is the subject matter of division 2. How to reconnect an existing stator winding for changes in voltage, phases, frequency or speed is dealt with in division 3. In this division a table is given showing operating voltage after reconnection, in percentage of original voltage for two- and three-phase windings having from 2 to 24 poles. For the practical electrical man and student the book contains a wealth of information and should find a wide field of usefulness with readers of these classes. Division 4 is devoted to unusual winding conditions. A treatment of how to test stator windings for faults is given in division 5. In division 6 are given 164 diagrams of single- two- and three-phase windings. These diagrams cover the possible connections from 2 to 24 poles.

Coke and Its Uses. By E. W. L. Nicol, Engineer and Fuel Expert to the London (England) Coke Committee. Published by Van Nostrand Company, 8 Warren St., New York City, 1924. Cloth; 8x10 in.; 134 pages; 33 illustrations and numerous tables. Price, $5 net.

The purpose of this book is to explain in non-technical language how gashouse coke may advantageously be used for many purposes instead of raw coal. After explaining what coke is and how it is made, the author takes up the various applications of this fuel with particular reference to steam raising. Detailed instructions are given for burning coke alone and in combination with other fuels. Attention is also given to its use for steam-operated motor vehicles and for domestic purposes. Clear illustrations and good printing in large type increase the attractiveness of this readable book.

Foreign Electrical Engineering Standards.—Copies of electrical engineering standards, issued during 1923 by European standardizing bodies, have been received by the American Engineering Standards Committee. Copies of the following can be furnished at a nominal charge, or copies on file may be consulted at the office of the American Engineering Standards Committee, 29 W. 39th St., New York City.

Belgium—Belgian Standards Association (Association Belge de Standardization) Rapport No. 14 Requirements for armoured cables, with impregnated paper insulation, for high voltages.

Czechoslovakia — Czechoslovakian Standards Society (Elektrotechnicker Svazu Ceskoslovenskeho). An illustrated booklet containing information regarding electrical standardization work and standards in Czechoslovakia. The Czechoslovakian Institute of Electrical Engineers reissued its Rules and Regulations in 1923. This is an illustrated handbook of over 500 pages, dealing with methods of measurement, rating, test, provisions for safety, care and operation of equipment; specifications for materials; government regulations effecting the industry, and many other items.

Germany—Standards Committee of German Industry (Normenausschuss der Deutschen Industrie) with the Union of German Electrical Engineers (Verein Deutscher Elektriker). Most of the electrical standardization work in Germany is carried out by the Verein in close touch with the central body. Its work is published in an annual volume of over 500 pages by Fisher.

Production and Briquetting of Carbonized Lignite. Bulletin 221, United States Bureau of Mines. E. J. Babcock and W. W. Odell in this pamphlet give the results of a series of experiments in the production and briquetting of carbonized lignite, made under a cooperative agreement between the Department of the Interior and the University of North Dakota. These experiments were conducted with certain inclined ovens for carbonization. A careful consideration of the methods of lignite carbonization and briquetting and resulting products as outlined in this bulletin will show that raw lignite can be converted into a very satisfactory fuel of comparatively high value, admirably suited to domestic and other uses and acceptable to the average consumer. This has been fairly demonstrated by extensive trial uses and tests. This pamphlet can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. for 20 cents.

Safety Code for Mechanical Power Transmission Apparatus; Rules for Guarding Prime Movers, Intermediate Equipment and Driven Machines. Approved by the American Engineering Standards Committee as a Tentative American Standard. Published jointly by the National Bureau of Casualty and Surety Underwriters, International Association of Industrial Accident Boards and Commissions and the American Society of Mechanical Engineers. Can be purchased from the Society of Mechanical Engineers, 29 West 39th St., New York City. Paper pamphlet. Price to members 60 cents and to non-members 65 cents.

Analyses of Samples of Delivered Coal, collected from July 1, 1915, to Jan. 1, 1922, with a chapter on The Tidewater Pool Classification, by Ned H. Snyder, Bureau of Mines. To be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. Paper. 174 pages. Price, 20 cents.

Annual Report of the Bureau of Standards to the Secretary of Commerce for the fiscal year ended June 30, 1923. Miscellaneous publications No. 53. Superintendent of Documents, Government Printing Office, Washington, D. C.

Handbook for Boiler Makers and Engineers; "World's Largest Plate Mill." Lukens Steel Co., Coatesville, Pa. Cloth. 5x7½ in.

House Votes in Favor of Ford Offer for Muscle Shoals

Vote Stood 227 to 142 in Favor of the McKenzie Bill—New Steam Plant To Be Included—Lease Runs 100 Years

HENRY FORD'S offer for Muscle Shoals, pending before Congress for more than two years, was approved on Mar. 10 by the House.

By a vote of 227 to 142 the McKenzie bill, which authorizes acceptance of Mr. Ford's bid, was passed and sent to the Senate, where there is uncertainty as to what action, if any, will be taken on it at this session.

The McKenzie measure was approved practically in the form in which it was reported by the Military Committee, which had been informed by Mr. Ford that he would take over the Government's nitrate and power project on the Tennessee River under the terms embodied in the bill.

Advocates of the Ford offer resisted to the last attempts to modify the proposed contract. Amendment after amendment aimed at the heart of the bill was thrown out by decisive vote, and as passed the measure carried fewer than half a dozen changes of minor importance which its supporters were willing to accept.

Attached to the bill, was the Madden amendment, approved by the Military Committee, which obligates the government to replace the Gorgas steam-power plant, recently sold to the Alabama Power Co. Provision is made that this plant—which is not to cost, with a transmission line to Nitrate Plant 2, more than the $3,472,487 received for the Gorgas plant—is to be sold to Mr. Ford, along with Nitrate Plants 1 and 2 and the Waco Quarry, near Russellville, Ala.

Under the terms of the bill Mr. Ford will have the right to lease for one hundred years Dams 2 and 3 at Muscle Shoals and adjacent power stations.

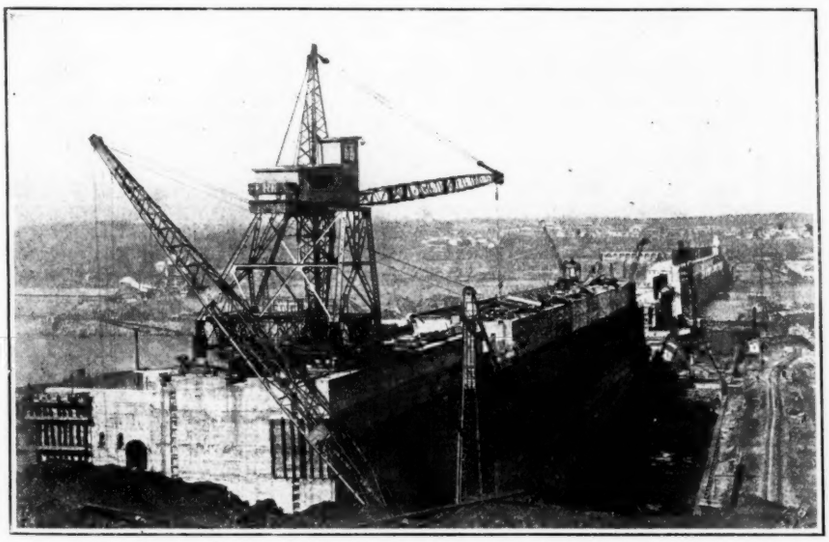
Outnumbered, but fighting stubbornly to the last roll call, opponents of the offer made a futile last-minute attempt to bring the project under the terms of the Federal water-power act, thereby limiting Mr. Ford's lease to fifty years, and to keep in the bill an amendment that would enable the Government to "recapture" the properties if the Detroit manufacturer failed to live up to his contract in any particular.

On the demand of Chairman Madden of the appropriations committee, a roll call was demanded just before the final vote on the amendment, and it went out of the bill by a vote of 197 to 176.

Party lines were disregarded to a large extent on the final vote, although Democrats as a rule supported the bill.

Electric Current not Dutiable

The Treasury Department has reaffirmed its position that electric current from Canada is not dutiable. The original decision to this effect was written June 25, 1890, and has controlled under the tariff acts enacted since.



Power house and Wilson Dam which is part of Muscle Shoals development

Several collectors of customs recently have written the Treasury Department for instructions as to electric current under the 1922 tariff act, and a general letter that such current is not dutiable has been issued, to be circularized among customs officials.

The letter points out, however, that poles, cables, wires and other articles used in transmission lines are dutiable under their respective provisions if imported in order to carry current into the United States.

First Unit Ordered for Des Moines

The Illinois Power & Light Corp. has ordered a G.-E. 20,000-kw. turbine-generator, the first unit destined for use in the Des Moines Electric Co.'s power station near Des Moines. Although the ultimate capacity of this plant may be larger, the building operations soon to begin will be for the accommodation of but two units.

The generating equipment just ordered will consist of a 20,000-kw. turbine direct-connected to a 60-cycle generator, rated 25,000-kva., 1,800 r.p.m., 13,800 volts. This unit, in turn, will drive a direct-connected exciter of sufficient capacity to excite two generators of the rating given. The turbine will be designed to operate with steam conditions of 350-lb. gage at the throttle, 250 deg. superheat, and one inch absolute back pressure.

New Boiler Laws Proposed for New York State

C. P. Miller has introduced a bill in the New York State Assembly amending Sec. 204 of the Labor Law by prescribing new conditions for the inspection of steam boilers. The principal differences in the proposed law from the one in force are: That at least once in each year the commissioner shall cause to be inspected all boilers used for generating steam, which carry a steam pressure of more than fifteen pounds to the square inch except where a report is filed with the commissioner within fourteen days from date of inspection by a duly authorized insurance company, certifying that such inspection shows the boilers are in safe condition and conform to the provisions of the law and rules and regulations of the board; every duly authorized insurance company shall report to the commissioner within the time limit prescribed in this section all boilers insured by it under the provisions of this section, including those rejected, together with the reasons in writing for such rejection; no boiler required to be inspected by the provisions of this section to be inspected unless by a

duly qualified boiler inspector who holds a certificate of competency issued by the industrial commissioner; fees for internal inspection are raised from five to six dollars and the amount for which each boiler may be liable, for a year from seven to eight dollars; every insurance company making an inspection of a steam boiler as required by this section shall forward together with the report of inspection, a fee of one dollar for each boiler inspected for the certificate of boiler inspection which shall be issued by the commissioner; a fee of ten dollars shall be charged by the commissioner for each boiler completely inspected by the department during the course of construction, when such boilers are manufactured within the State of New York; the boiler owner or lessee allowing, permitting or suffering its use when in an unsafe or dangerous condition shall be subject to a fine of fifty dollars for each day on which it is used after receipt of notice.

The provisions of this section do not apply to cities where inspectors operate under the authority of local laws, etc.

Kelvin Centenary Celebration Program

The provisional program for the Kelvin Centenary Celebration, which is to be held in connection with the World Power Conference on July 10 and 11, has recently been received in New York. It is as follows:

July 10—4:30 p.m., presentation of the Kelvin Medal to Professor Elihu Thomson; 5 p.m., presentation of addresses by delegates from the bodies represented on the Committee of Honor; memorial oration by Sir J. J. Thomson C. M., F. R. S.; 9 p.m., reception of delegates by the president of the Royal Society.

July 11—6:45 p.m., Kelvin dinner. The Right Hon. Earl Balfour, C. M., in the chair.

Production of Electricity Greatest in January

The average daily production of electricity by public-utility power plants in January exceeded all previous records of output, with a production of 167,000,000 kw.-hr. per day. This figure exceeds the previous records established in November by about 3.5 per cent. The total output for the month was 5,177,000,000 kw.-hr. This is the first time that the five-billion mark for a single month's output has been passed. About one-third of the total output was produced by the use of water power, as shown by the table at the bottom of this page.

U. S. Peat Investigation Is Under Way

W. W. Odell, fuel engineer, Department of the Interior, has begun the study of peat as a fuel, and is spending some time at the Minneapolis experiment station of the Bureau of Mines, which is in the northern peat district. So far, the work has consisted in making preliminary studies as to the best methods of attacking the problem with the funds available.

Detroit Gets New Turbine-Generator

The first unit of three G. E. 50,000-kw. turbine-generators has been shipped to the Detroit Edison Co. for installation in the new Trenton Channel Station at Detroit. The ultimate capacity of this station will be about 300,000 kw. The unit just shipped is rated at 50,000 kw. at 80 per cent power factor, or 62,500 kva. It is a 60-cycle 1,200-r.p.m. machine designed to operate at 375 lb. gage pressure and 250 deg. F. superheat. It will be, when installed, one of the largest single-cylinder machines in operation.

Decision on Trade Statistics Vital to Industry

The situation in regard to the legality of collecting trade statistics is becoming acute in the coal industry, where comprehensive and accurate statistics are more important at this time than in any other industry.

It is believed that some way can be found to secure from the administration a definite statement of policy in connection with trade statistics. The position of Secretary Hoover is generally known. His efforts to clear up the situation so far have been futile, as was indicated by the correspondence with the Attorney-General.

It is now suggested that one of the coal trade associations might be able to secure a pronouncement of administration policy were it to make a very definite offer to the Department of Commerce to furnish it with full statistical reports, accompanied by a specific statement that it did not expect any guarantee of immunity from prosecution and that information gathered would be available to all concerned on equal terms.

A test suit by the Department of Justice against an association engaged in clear-cut statistical activities would, however, be the simpliest and best way of clearing up this question, so vital to industry.

Increase in Export of Leather Belting

The United States exported 71,360 lb. of leather belting, valued at $102,168, during the month of Jan., 1924, as compared with 66,496 lb., valued at $112,433, during the corresponding month of 1923. It is noted that during the first month of 1924 the South American trade purchased nearly 8,500 lb. more than in January, 1923, while British Indian took approximately 2,000 lb. and Japan about 900 lb. in excess of their January, 1923 purchases. The decrease in shipments to Cuba, Canada, Mexico, and China, however, so offset these increases that the net gain was only about 5,000 lb.

The following countries were the leading foreign markets for American leather belting during January, 1923 and 1924:

UNITED STATES EXPORTS OF LEATHER BELTING

Countries of Destination	January 1923 Lb.	January 1924 Lb.
United Kingdom	1,900	1,202
Canada	8,600	7,877
Mexico	5,295	1,993
Cuba	10,092	8,811
South America	7,075	15,463
British India	1,914	3,919
China	18,777	14,831
Japan	5,375	6,211
Philippine Islands	703	1,453
Other Countries	6,765	9,600
Total	66,496	71,360

New Firm of Hydro-Electric Engineers Formed

John L. Harper, vice-president and chief engineer of the Niagara Falls Power Co., and H. Birchard Taylor, vice-president of the William Cramp & Sons Ship and Engine Building Co., announce the formation of Harper & Taylor, Inc., with offices in Philadelphia, Bankers Trust Bldg., and Niagara Falls, N. Y., at 1445 Buffalo Ave. The firm will conduct a general engineering business, paying particular attention to the design, construction and operation of hydro-electric projects.

The officers and staff will be as follows: President and general manager, H. Birchard Taylor; vice-president and chief engineer, John L. Harper; mechanical engineer, H. P. Rust; hydraulic engineer, Norman R. Gibson; electrical engineer, J. Allen Johnson; civil engineer in charge of construction, Oliver D. Dales; civil engineer in charge of structural design, Louis S. Bernstein.

All the men identified with the new organization have been long and intimately associated with the development of water-power projects. The new company will have charge of the engineering work of the Niagara Falls Co.

PRODUCTION OF ELECTRIC POWER AND CONSUMPTION OF FUEL BY PUBLIC-UTILITY POWER PLANTS IN THE UNITED STATES FOR NOVEMBER AND DECEMBER, 1923, AND JANUARY, 1924

Thousands of Kilowatt-hours

Division	By Water Power November	By Water Power December	By Water Power January	By Fuels November	By Fuels December	By Fuels January	Total November	Total December	Total January
United States	1,501,349	1,682,183	1,697,107	3,336,181	3,274,288	3,479,877	4,837,530	4,956,471	5,176,984
New England	115,490	142,345	138,888	251,886	234,475	256,952	367,376	376,820	395,840
Middle Atlantic	337,922	410,610	426,866	997,398	991,803	1,031,709	1,335,320	1,402,413	1,458,575
East North Central	117,779	127,005	110,754	1,001,613	1,024,681	1,121,755	1,119,392	1,151,686	1,232,509
West North Central	74,981	73,125	51,571	268,052	274,211	295,884	343,033	347,336	347,455
South Atlantic	168,842	186,083	209,107	361,282	320,347	333,108	530,124	506,430	542,215
East South Central	58,325	102,873	114,420	115,992	64,050	63,905	174,317	166,923	178,325
West South Central	767	766	937	148,902	153,905	157,816	149,669	154,671	158,753
Mountain	193,621	202,307	208,673	37,351	41,020	41,065	230,972	243,327	249,738
Pacific	433,622	437,069	435,891	153,705	169,796	177,683	587,327	606,865	613,574

Note—Compiled by Division of Power Resources, Geological Survey.

Combustion Engineering Corp. Associated with Stinnes

The "Carbo Union Industry Association" is the name of the company which the Combustion Engineering Corp., Hugo Stinnes and Mathias Stinnes have recently organized to operate in Holland, Germany and Central Europe.

This organization for world-wide exploitation of certain of its processes and patents is in line with the policy of the Combustion Engineering Corp., which has already organized in Canada, England, France and now Holland.

George E. Learnard, the president, sailed for London on the "Berengaria," Mar. 8, to make necessary arrangements in connection with the European expansion. The chief process of the Combustion Engineering Corp. which it is believed the Stinnes interests would desire provides for the preparation of pulverized coal.

Large Kansas Power Plant Under Way

Progress is being made on the new steam-generating electric power plant that is being built by the Illinois Power & Light Corp. at Tecumseh, Kan., to furnish Topeka, Atchison and other communities in Kansas with power.

A steel-tower transmission line six miles long is now under construction between the new Tecumseh plant and Topeka, which will supply farms along its route with electricity in accordance with the movement in the state to furnish power for use on farms.

Another line, 50 miles in length, will be built from the new power station to Atchison. There is a possibility, too, of this line serving farms with power.

The ultimate capacity of the Tecumseh plant will be 60,000 kw.; the first installation will be 15,000 kw., which, including the transmission line, will cost $2,750,000.

Work on the first two units was begun two months ago. It is hoped to have the present development completed by the end of the year.

Pulverized Fuel Will Be Used at Miami Fork Station

Contracts have been closed by the Columbia Power Co., Cincinnati, for the sub-structure, pulverized-fuel equipment, boilers and economizers and turbo-generators for the new Miami Fork station which is being erected in the southwestern corner of Ohio. This station will operate on powdered fuel. Steam will be supplied at the turbine throttle at 550-lb., 725-deg. Energy will be transmitted at 66 kv. to the Union Gas & Electric Co., at Cincinnati, over a 22-mile transmission line which is being built by the latter company.

The new station will be situated at the junction of the Ohio and Miami Rivers, where plenty of circulating water will be available for any ultimate development now considered, and space, 1,500 acres, will be afforded for coal storage and industrial development. It will be possible to receive either river coal or coal delivered over the Baltimore & Ohio Railroad.

The initial generator installation will consist of two 40,000-kw. tandem-compound G. E. turbo-generators. Steam will be taken from the high-pressure stage at 122 lb. and reheated to 700 or 725 deg.

Contracts have been placed with the Fuller Engineering Co. for complete pulverized-fuel equipment, including improved separately fired rotary driers, pulverizing mills with screen separation, coal conveyors, weighing equipment, bunker-filling control and furnace equipment.

Provision will be made for preheating the air to the furnaces, but the type of air economizer has not yet been determined. The Babcock & Wilcox Co. will furnish eight 650-lb. standard boilers, six of which will have 15,110 sq.ft. of heating surface with superheaters and steel economizers. Two will contain 6,066 sq.ft. of saturated-steam heating surface, 1,610 sq.ft. of primary superheater surface and 17,275 sq.ft. of reheat superheat surface besides the steel economizers. Work has begun on the plant substructure.

St. Louis Has Huge Development Program Outlined

The tremendous program contemplated by the Union Electric Light & Power Co. of St. Louis, was indicated by President Louis H. Egan in a recent address, when he announced that the company planned to expend $100,000,000 in the St. Louis district within the next six years. The company, he said, will spend $5,000,000 additional on the Cahokia power plant during 1924. Already $12,000,000 has been expended on this plant, which is only one-third its eventual size. Completed, it will represent an investment of $35,000,000 and will involve double that amount in cables, conduits, transformers, substations and other equipment. "Perhaps it may seem still more startling to you," Mr. Egan concluded, "when I say that if the demand of this district continues to increase at its rate of the last twenty years, even with gigantic Cahokia completed we shall face the necessity of building almost immediately another plant of like proportions —a second superpower plant."

Malay States Plan Power Project

As stated in a recent issue of *Power*, proposals to harness the Perak River in the Federated Malay States have been made in view of the increasing demand for electric power in that vicinity. An abundant supply of hydro-electric power can be obtained from this river, and the extensive tin mines in the Kinta Valley in the District of Larut, together with the Federated Malay States railways would provide ample outlet for the power which could be generated.

The Perak River at Parit is within 8 miles of Batu Gajah, which is regarded as the center of the Kinta mining fields. Surveys have been made of a dam site above Enggor, which is the most promising of all the localities considered. The transmission lines from this site would run close to good roads and railway lines, thus cheapening the cost of construction and maintenance.

If later on, further power should be required, other dams could be built across the same river higher up. The potential power available is estimated at about 20,000 kw. from the Perak River only, which is sufficient to take care of all anticipated needs.

It may be assumed that in a few years a demand will arise for about 30,000,000 kw.-hr. per annum, rising later on to a considerably higher figure.

Local engineers recommend that generation should be three-phase, 50- or 60-cycle alternating current, stepped up to 66,000 volts for transmission.

Water Power on Danube Being Studied

Utilization of the power in the Danube is being projected on a large scale by the Bavarian government, according to recent press reports. Similar work on a smaller scale is also going on at Budapest, where a small fall near the island of Csepel is being used for power to light the capital. The utilization of the immense water power of the Danube is being studied by all the countries through which the river passes, as the coal situation is becoming everywhere more acute.

N. Y. Water Power Authority Bill Meets Opposition

At a joint Senate and Assembly hearing held at Albany on March 12 unexpected opposition to the administration bill was given by people whose support had been expected. The Democratic bill is known as the Rabenold-Hackenburg bill; the Republican measure the McGinnies assembly bill. They differ mainly in but two respects: The Democratic measure cedes all right and title from the state to the power authority and provides that bonds shall be sold only on security of revenues to be derived from the project; the Republican measure pledges the properties of the authority as well as the revenues towards the payment of the bonds.

The opposition to the administration bill came from attorneys appearing for various interests, principally the town of Oswego and the New York City water supply system. The general objections raised to both bills coming from corporations, were that the present water-power act allows of private development, if the state will permit the present water power commission to function and act on the permits already before it; that the task of making the survey, preparing the plan and estimate of cost together with the scheme of financing the project will be in itself a super-project requiring super-men; that it will require the best lawyer, the best engineer and the highest-class banker to make up the commission; that the cost will be enormous and that eventually the credit of the state must be pledged; that under either bill the state threatens to go into the business in competition with its citizens that will require an ultimate capital of upward of a billion dollars.

Tentative Program A.I.E.E. Meeting Announced

The Spring meeting of the A.I.E.E. to be held in Birmingham, Ala., April 7-11, will stress hydro-electric features. The papers that will be of interest to *Power* readers are as follows:

April 7: Afternoon—"Hydro-Electric Practices and Equipment in the South," by O. G. Thurlow; "Hydro-Electric Practices and Equipment on the Pacific Coast," by S. Barfoed; "Development in Hydro-Electric Equipment," by W. M. White; "Acceptance Tests on Hydro-Electric Stations," by F. H. Rogers.

April 8: Morning—"Lightning Arrester Experience of the Coast," by E. R. Stauffacher; "Lightning Arrester Design and Operation," by C. E. Bennett; "Economics of Lightning Arresters," by A. L. Atherton; "Operating Experience with the Relaying on the Duquesne System," by H. P. Sleeper. Afternoon—"Analysis of Water Powers of the South," by C. O. Lenz; "National Water Power Development," by O. C. Merrill; "Southern Power Developments," by Thomas W. Martin; "Public Relations in Power Development," by Preston Arkwright; "Financial Aspects of Hydro-Electric Developments," by H. M. Addinsell.

April 9: Morning—"Alabama Power Co. Breaker Tests," by R. W. McNeill; "Oil Breaker Tests," by A. J. D. Dillard; "Oil Breakers from an Operator's Viewpoint," by J. V. Jenks.

April 10: Morning—"New Synchronous Induction Motor," by Val A. Fynn; "65,000-kva. Generators at Niagara Falls," by W. J. Foster; "22,000-kva. Transformers at Niagara Falls," by F. F. Brand. Afternoon—"Effect of Impurities on Battery Electrolyte," by G. W. Vinal and F. W. Altrup.

April 11: Inspection trip and visit to Lock 12 and Mitchell Dam.

Canada's World Power Conference Program

Great interest in the coming World Power Conference, to be held in London from June 30 to July 12, is reported from Canada.

At least five papers will be presented at the conference by Canadian delegates. These are: "Review of Power Situation in Canada," by J. B. Challies, Director of Water Power for the Dominion; "Power Production," by H. G. Acres, chief hydraulic engineer Ontario Hydro-Electric Commission; "Power Transmission," by Julian C. Smith, president Quebec Power Company; "Hydro-Electric Energy in Industry," by P. T. Davies, president Canadian Electrical Association, Montreal, and "Carbo-Power Production in Canada," by B. F. Haanel, chief of the Fuel Commission, Department of Mines.

Notice of the steamers carrying Canadian delegates was given in Mar. 4 *Power*. For any information in regard to Canadian participation, address J. B. Challies, general secretary, Dominion Water Power Branch, Department of the Interior, Ottawa, Ont., Canada.

Coming Conventions

American Association of Oil Burner Manufacturers. No. 518 Bank of Galesburg Bldg., Galesburg, Ill. First annual meeting at Hotel Chase, St. Louis, Mo., April 1-3.

American Chemical Society. Charles L. Parsons, 1709 G St. N.W., Washington, D. C. Annual meeting at Washington, D. C., April 21-25.

American Electrochemical Society. C. G. Fink, Columbia University, New York City. Meeting at Hotel Bellevue-Stratford, Philadelphia, Pa., April 24-26.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Spring convention at Birmingham, Ala., April 7-10.

American Society of Civil Engineers. John H. Dunlap, 29 West 39th St., New York City. Spring meeting at Atlanta, Ga., April 9-12.

American Society of Mechanical Engineers, Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Cleveland, Ohio, May 26-29.

American Water Works Association. J. M. Diven, 153 West 71st St., New York City. Annual convention at New York City, May 19-21.

American Welding Society, Miss M. M. Kelly, 29 West 39th St., New York City. Annual meeting at New York City, April 23-25.

Association of Iron and Steel Electrical Engineers. W. M. Chandler, 708 Empire Building, Pittsburgh, Pa. Fuel Saving Conference—Combustion Engineers. April 2-3 at Wm. Penn Hotel, Pittsburgh, Pa.

Eastern Ice Manufacturers' Association. W. H. Ross, 35 Warren St., New York City. Spring meeting at Hotel Adelphia, Philadelphia, Pa., April 2-3.

Electric Power Club. S. N. Clarkson, Keith Bldg., Cleveland, Ohio Meeting at Seaview Golf Club, Absecon, N. J., May 26-29.

International Railway Fuel Association. J. B. Hutchinson, 6000 Michigan Ave., Chicago. Annual convention at Hotel Sherman, Chicago, Ill., May 26-29.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Meeting at Chicago, May 20-23, 1924.

National Association of Stationary Engineers. Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Grand Rapids, Mich., Sept. 8-13. Annual conventions and exhibitions of the state associations are scheduled as follows: **Kansas Association** at Parsons, Kans., April 16-18. J. M. VanSant, 739 Horne St., Topeka, Kan. **Indiana Association** at Lafayette Ind., May 5-6. Prof. A. W. Cole, Purdue University, Lafayette, Ind. **New Jersey Association** at Newark, June 6-8. Joseph P. Flynn, 612 Franklin St., Elizabeth, N. J. **Iowa Association** at Sioux City, June 10-14. Abner Davis, 16 Waterhouse Block, Cedar Rapids, Iowa. **Ohio Association** at Akron, June 19-21. T. S. Garrett, 2622 East Second St., Dayton, Ohio.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St. New York City. Annual convention at Atlantic City, Young's Million-Dollar Pier, May 19-24. **Nebraska Section,** H. M. Davis, Banker's Life Bldg., Lincoln, Neb. Sectional meeting at Omaha, May 8-9. **Southwestern Division.** S. J. Ballinger, San Antonio Public Service Co., San Antonio, Texas. Divisional meeting at New Orleans, April 22-25.

Society of Industrial Engineers. George C. Dent, 608 South Dearborn St., Chicago, Ill. Eleventh annual convention at Buffalo, N. Y., April 30 to May 2, 1924.

World Power Conference. O. C. Merrill, Federal Power Commission, Washington, D. C. British Empire Exhibition, Wembley, London, June 30-July 12.

Society Affairs

The Vancouver, Wash., Section of the A.I.E.E. will hear J. R. Read on the "Development of Bridge River Power Project," at its April 4 meeting.

The Detroit Section of the A.S.M.E. will hold a dinner meeting on Mar. 20 at which Fred R. Low will be the principal speaker.

The Boston Section of the A.S.M.E. will consider "Domestic Oil Burners from an Engineering Standpoint," at its March 20 meeting. Maurice M. Osborne will be the speaker.

The Society of Safety Engineers of California and the Engineering Section of the National Safety Council will hold a joint conference at the St. Francis Hotel, San Francisco, Calif., April 7-9.

The Grand Rapids Section of the A.S.M.E. will hold a joint meeting with other engineering societies sections of Grand Rapids, on March 19, at which Fred R. Low and other members of the Council of the A.S.M.E. will speak.

The Providence Engineering Society will hear Charles L. Kassen of the Edison Illuminating Co., Boston, Mass., at a meeting of its Power Section on Mar. 28. The subject will be "Laboratory Work in an Electric Public Utility Company."

The Metropolitan Section of the A.S.M.E. will have "Boiler Furnace Design," by E. B. Ricketts, and "A New Design of Water Wall Construction for Boiler Furnaces," by Thomas E. Murray on the program of its meeting for the evening of March 24.

The Virginia Sections of the A.S.M.E., A.S.C.E. and **A.I.E.E.** will hold a joint meeting at Lynchburg, Va., on March 28. The program will be: "Location of Industrial Plants in Regard to Balance of Community," by a speaker to be selected by the A.S.C.E.; "Development and Distribution of Power for Industrial Purposes," by a speaker to be furnished by the A.I.E.E. "Industrial Heating" by G. B. Nichols; "Development of Dan River Cotton Mills," by George V. Robertson; "Carrier Engineering Co.'s Products as Applied to Industrial Buildings," by a speaker to be furnished by the Carrier Engineering Co.

Business Notes

The McMyler Interstate Co., Bedford, Ohio, has moved its Chicago office to 648 Railway Exchange Building.

The Mitchell-Tappen Co., manufacturers of floor gratings, 15 John St., New York City, announces the appointment of the Steel Specialties Co. of Atlanta, Ga., as its representative for the sale of gratings in the South.

The Wheeler Condenser & Engineering Co., Carteret, N. J., has absorbed the Alberger Pump & Condenser Co. of New York City. The Alberger works at Newburgh will be used for building pumps and other auxiliary apparatus, while the Carteret works will manufacture the large condenser equipment.

Trade Catalogs

Filter.—Streamline Filter Corp., 95 Liberty St., New York City. Catalog illustrating Hele-Shaw system of filtering liquids.

Heater, Unit—L. J. Wing Manufacturing Co., 352 West 13th St., New York City. Leaflet describing this featherweight unit heater contains illustrations of installations and data concerning dimensions and engineering.

Cranes and Shovels, Convertible—The McMyler-Interstate Co., Cleveland, Ohio. Bulletin No. 59 gives descriptions and illustrations of the No. 2 convertible hoisting mechanism actuated by steam engine, gas engine or electric motor.

Refractories — Furnace Specialties Co., Inc., 26 Cortlandt St., New York City. Booklet "Ganisand," describes with appropriate illustrations the use of this material for lining and repairing industrial furnaces and making refractory tile and special shapes.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Mar. 3, 1924	Mar. 10, 1924
Pool 1	New York	$3.25	$3.25
Smokeless	Columbus	2.25	2.25
Clearfield	Boston	2.40	2.40
Somerset	Boston	2.50	2.60
Kanawha	Columbus	1.75	1.65
Hocking	Columbus	2.00	2.00
Pittsburgh No. 8	Cleveland	1.85	1.90
Franklin, Ill.	Chicago	2.50	2.50
Central, Ill.	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.50	2.50
West Ky.	Louisville	1.90	1.90
S. E. Ky.	Louisville	2.00	2.00
Big Seam	Birmingham	1.85	1.85

FUEL OIL

New York—March 13, light oil, tank-car lots, 28@34 deg. Baumé, 5c. per gal., 36@40 deg. 5¼c. per gal., f.o.b. Bayonne, N. J.

St. Louis—March 7, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.95 per bbl.; 26@28 deg., $2; 28@30 deg., $2.05; 32@36 deg., gas oil, 5.525c. per gal.; 36@40 deg., 6.525c. per gal.

Pittsburgh—March 4, f.o.b. local refinery, 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., fuel oil, 6c.; 34 deg., neutral, 10c. per gal.

Cincinnati—March 11, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6c. per gal.; 26@30 deg., 6¼c. per gal.; 30@32 deg., 6¾c. per gal.

Dallas—March 7, f.o.b. local refinery, 26@30 deg., $1.30 per bbl.

Philadelphia—March 7, 28@30 deg., $2.31@$2.36 per bbl.; 18@22 deg., $2.10 @$2.16½; 13@16 deg., $1.68@$1.74½ per bbl.

Boston—March 10, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4¼c. per gal., light oil, 28@32 deg. Baumé, 6¼c. per gal.

New Plant Construction

Ala., Jasper—The Deep Water Coal Co. recently organized with a capital of $20,000,000, is reported to be planning for the construction of a large coal-handling plant on site acquired on Dauphin Island, Mobile, Ala., to cost in excess of $200,000, with machinery. L. B. Musgrove, Jasper, is one of the heads of the company.

Ala., Tuscaloosa—The City Council plans for the installation of electric-operated pumping equipment in connection with proposed extensions and improvements in the waterworks, estimated to cost $150,000. Morris Knowles, Inc., Westinghouse Building, Pittsburgh, Pa., is engineer.

Ark., Nashville—P. C. Allen, Nashville, and associates plan for the construction of a power house at their proposed cement manufacturing plant in this section, to cost in excess of $500,000, with machinery. A company with capital of $1,000,000, is being organized to carry out the project.

B. C., Victoria—The Department of Public Works will take bids at an early date for the construction of a central power plant and heating station at Essondale, estimated to cost $100,000.

Calif., Auburn—The Bear River Water & Power Co. has made application to the State Department of Public Works for permission to use waters from the Bear River for the construction and operation of three hydro-electric generating plants, with total capacity of 43,000 hp.

Calif., Fallbrook—The Fallbrook Irrigation Co. plans for the installation of electric-operated pumping equipment fn connection with a proposed irrigation project, utilizing waters from the Santa Margarita River, estimated to cost $750,000. The water will be pumped through about 8,000 ft. of 24-in. pipe line.

Calif., Fresno—The Danish Creamery Association, E and Inyo Streets, has plans for the construction of an addition to its plant, to be equipped for ice-manufacturing. The Ernest J. Kump Co., Rowell Building, is architect.

Calif., Monte Vista—The West Ontario Citrus Association has tentative plans for the installation of an ice and pre-cooling plant in its proposed local packing house, estimated to cost approximately $200,000. William Hartley is general manager.

Calif., Napa—The Pioneer Fruit Co. will commence work on a one-story ice and pre-cooling plant, 50 x 100 ft., on Vallejo Street, near Wallace Street.

Calif., Pine Knot — The Bear Valley Utility Co. has plans under way for the installation of a waterworks and system for local service, to include two pumping units and auxiliary power equipment. The project will involve about $115,000. Chester H. Loveland, Balboa Building, San Francisco, is engineer.

Calif., Santa Rosa — The City Council plans for the installation of electric-operated pumping machinery at the proposed sludge sewerage disposal works, for which bonds in an amount of $165,000, have been approved. Clyde F. Smith, 615 Santa Barbara Road, Berkeley, Calif., is engineer.

Conn., Bristol—The Bristol & Plainville Electric Co. will commence the immediate erection of a one-story addition to its power plant, 24 x 50 ft., to be used as a generator room. Lewis A. Miller, 22 Church Street, Meriden, Conn., is architect.

Conn., East Hartford — John Treblas, care of Fred C. Walz, Trumbull Street, Hartford, architect ,will build a boiler plant at his proposed factory on local site, for which plans are being completed.

Egypt, Cairo—The Bureau of Foreign and Domestic Commerce, Washington, D. C., has received an inquiry from a company at Cairo, in the market for pumping machinery; name, details, etc., on application, reference No. 9313.

Fla., Cocoanut Grove — The Common Council has called a special election April 15 to vote bonds for $200,000, for a municipal waterworks, including electric-operated pumping equipment and auxiliary power apparatus.

Fla., Hialeah—H. E. Ellis, 27 Seventh Avenue, is arranging plans for the organization of a company to construct and operate a local paper mill. The plant will include a power house, and is estimated to cost in excess of $350,000.

Fla., Jacksonville — The Florida Paper Mills, Inc., operated by the Grass Fibre Pulp & Paper Corp., Leesburg, Fla., plans for the construction of a power house at its local mill, for which erection plans are maturing and work on initial units will soon commence. It will cost in excess of $400,000, with machinery. Gilbert Leach is treasurer of the parent organization, in charge. (Incorrectly noted under "Jacksonville, Tex.," issue March 11.)

Fla., Jacksonville—The Shearman Concrete Pipe Co., Knoxville, Tenn., contemplates the construction of a boiler plant at its proposed local branch works, on site recently acquired, estimated to cost about $50,000.

Fla., Miami—The Wilson Investment Co., A. K. Wilson, president, plans for the installation of a pumping plant for waterworks service on a tract of land at Dearborn Park to be developed for residential purposes.

Fla., Monticello—J. A. McClellan, Monticello, is perfecting plans for the construction of a one-story ice-manufacturing and cold storage plant on local site, with reported cost placed at $40,000, including equipment.

Fla., Orlando—The Central Produce Co. is perfecting plans for the construction of a new cold storage plant on Chicago Avenue.

Ga., Atlanta — Dr. N. P. Pratt, local capitalist and engineer, has organized a new company with capital of $5,000,000, to construct and operate a hydro-electric power plant on the Coosawattee River, near the junction of Flat Creek, Gilmer County. The dam will be 250 ft. high; the generating station will have an initial output of 45,000 hp. Charles O. Lenz will be engineer for the project.

Ga., Lawrenceville—H. C. Crisp is planning for the purchase of an engine and auxiliary equipment for power supply for a proposed shingle mill.

Ga., Macon—The Macon Veneer Co. is said to be planning for the construction of a boiler plant in connection with the proposed rebuilding of its local mill, recently destroyed by fire with loss approximating $55,000.

Ind., Bloomington — The City Council contemplates the installation of electric-operated pumping equipment in the proposed new station at Griffy Creek, estimated to cost $125,000, with machinery.

Ind., St. Paul—The Hoosier Hydro-Electric Co., Indianapolis, recently organized by John A. Shafer, local consulting engineer, has applied for permission to proceed with the construction of its proposed hydro-electric generating plant on Flat Rock Creek, near St. Paul, estimated to cost approximately $1,000,000.

Iowa, Davenport—The Linwood Cement Co. plans for the construction of a boiler plant at its proposed local mill, estimated to cost $100,00. A. C. Klindt is one of the heads of the company.

Iowa, Marshalltown—The City Council has called a special election on March 28 to vote bonds for $300,000, for extensions and improvements in the municipal waterworks, to include the installation of electric-operated pumping equipment. A. T. Luce is waterworks superintendent.

Iowa, Webster City—The American Cement Plaster Co., Fort Dodge, Iowa, is reported to be planning for the construction of a boiler plant at its proposed local mill, estimated to cost $75,000.

Ky., Louisville — The Ford Motor Co., Highland Park, Detroit, Mich., has completed plans and will soon break ground, for its proposed local assembling plant, to include a power house, estimated to cost $500,000. Albert Kahn, Marquette Building, Detroit, is architect.

La., Lake Providence — The Common Council contemplates the installation of

electric-operated pumping machinery in connection with a proposed sewerage system, estimated to cost $85,000.

La., Ferriday — The Town Council will receive bids until March 25, for equipment for a waterworks plant, including pumping machinery and auxiliary power equipment. Henry A. Mentz, Magnolia, Miss., is consulting engineer.

La., Monroe—The Monroe Mill Work & Box Co., Inc., recently organized, plans for the construction of a boiler plant at its proposed woodworking factory on site selected in South Monroe. C. C. Bell is head.

Md., Hagerstown—The State Legislature has passed a bill, now awaiting the Governor's approval, exempting the local municipal electric power plant from the jurisdiction of the State Public Service Commission, arranged to allow the city to make extensions, including the installation of additional equipment, and to issue bonds for such purpose.

Mass., Cambridge—H. P. Hood & Sons, 155 Massachusetts Avenue, dairy products, have filed plans for the erection of a one-story boiler plant to cost about $30,000, and will proceed with work at once.

Mass., Boston—The Libby & Libby Co., 24 North Street, meats, will soon take bids for alterations and improvements to its cold storage plant at 28-40 North Street, including the installation of additional equipment. H. M. Haven and A. T. Hopkins, Inc., 40 Court Street, is architect.

Mass., Monson — The Rubwood Wheel Co., Inc., plans for the construction of a steam-operated electric power plant in connection with a new three-story factory addition.

Mass., Winchester — The Board of Trustees, Winchester Hospital, Highland Avenue, plans for the construction of a power house and mechanical laundry at the institution. Kendall Taylor & Co., 142 Berkeley Street, Boston, Mass., are architects.

Mich., Berkley — The Common Council plans for the installation of electric-operated pumping machinery in connection with the proposed municipal waterworks, estimated to cost $200,000. R. A. Murdock, Free Press Building, Detroit, is engineer.

Mich., Escanaba—Following a consolidation of the Escanaba Power & Traction Co., and the Escanaba Paper Co., plans are being arranged for extensions and improvements in the hydro-electric power plant in the vicinity of Groos, Mich., estimated to cost $100,000, including equipment.

Minn., Cannon Falls—The Cannon River Hydro-Electric Co. has tentative plans for the construction of a hydro-electric generating plant on site about 2½ miles from Cannon Falls, estimated to cost $260,000. J. H. A. Brahtz, Metropolitan Opera House Building, St. Paul, Minn., is engineer.

Minn., Minneapolis—The Ronning Machinery Co., 300 Washington Avenue, N., plans for the construction of a boiler plant at its proposed new local works, estimated ot cost $80,000. A. G. Ronning is president.

Minn., Minneapolis — The Waterworks Department, City Hall, J. A. Jensen, supervisor, is having plans prepared for the construction of a pumping station, with electric-operated equipment, and filtration plant at Fridley Park, estimated to cost $350,000. Fallows & Huey, New York Life Building, are architects.

Minn., Willmar—The City Council plans for the installation of electric-operated pumping machinery in connection with a proposed sewerage disposal plant and extensions in sewerage system. Plans are being prepared. Claussen & Carroll, Metropolitan Bank Building, St. Paul, Minn., are engineers. Hans Gunderson is city clerk.

Miss., Coldwater—C. L. Graham and associates are perfecting plans for the construction of a local ice-manufacturing plant, with initial capacity of about 20 tons per day.

Miss., Pascagoula—The Grubb Mfg. Co., recently organized, plans for the construction of a boiler house at its proposed local woodworking plant, two-story, 30 x 75 ft., for which a site has been selected. C. W. Grubb is president.

Mo., St. Joseph—The Collier-Adams Mfg. Co., Fourth and Mitchell Streets, manufacturer of sash, doors, etc., plans for the construction of a new boiler plant, 35 x 36 ft., in connection with other factory additions, estimated to cost $80,000. E. R. Meier, Lincoln Building, is architect.

Mo., St. Joseph—The St. Joseph Water Co., Eighth and Francis Streets, C. H. Taylor, president, is arranging a list of equipment to be installed in connection with proposed improvements and extensions, including two 350 hp. high pressure boilers, to cost about $30,000; one 12 million g.p.d. high service pump, $60,000; one pump, like capacity, low service, $25,000; new steam lines, $10,000; new boiler house, $50,000; auxiliary equipment etc.

Mo., Thayer—The Common Council will defer temporarily the erection of its proposed municipal ice-manufacturing plant on local site, and is expected to call for new bids in the near future.

Mont., Livingston—The City Council has called a special election on April 7, to vote bonds for $45,000, for a municipal waterworks, to include the installation of electric-operated pumping machinery. Harry M. Shelver is city clerk.

Neb., Hastings—Plans are being completed and bids will soon be asked for the construction of a municipal electric power plant and water station, two-story and basement, 40 x 90 ft., estimated to cost $40,000. P. T. Naylor is engineer in charge.

N. J., Morris Plains—The Commissioner of Institutions and Agencies, State Office Building, West Hanover Street, Trenton, will take bids until March 26, for a new boiler plant at the local state hospital. It will have a capacity of 1,700 hp., with equipment to include boiler units, pumping machinery, stack, etc. Plans and specifications at the office of the Division of Architecture and Construction of the department.

N. J., Paterson—The Alexander Hamilton Hotel, 176 Ellison Street, Maurice Meyer, chairman of building committee, plans for the installation of a boiler plant in the new local hotel, estimated to cost $1,500,000. Guilbert & Betelle, Chamber of Commerce Building, Newark, N. J., are architects. Erection will soon be commenced.

N. Y., Brooklyn — Benjamin Sackheim, 164 Montague Street, architect, has plans nearing completion for the erection of a one-story ice-manufacturing plant, 90 x 100 ft., on local site, to cost about $43,000, for which the owner's name is temporarily withheld.

N. C., Dunn—The Board of Town Commissioners will receive bids until March 27, for waterworks and sewerage equipment, include motor-driven centrifugal pumps and auxiliary apparatus; steel water tank and tower; pumping station building, etc., as per plans and specifications at the office of the Gilbert C. White Co., Durham, N. C., engineer. H. A. Parker is town clerk.

N. C., Robersonville—The Common Council has advanced its plans for the proposed municipal waterworks, and will take bids for equipment until March 26, including pumping machinery, steel water tank and tower, and auxiliary apparatus. The Carolina Engineering Co., Wilmington, N. C., is engineer.

N. C., Shaleton — The Seaboard Shale Brick & Tile Co., Charlotte, N. C., is said to be planning for extensions in the steam power house at its local plant in connection with proposed extensions for considerable increase in output. C. B. Marcom is president.

Ohio, Cincinnati—The Chief of Engineers, United States Army, Washington, D. C., has authorized the construction of power houses at dams 34, 36 and 38, Ohio River. Plans will be prepared and bids asked by the district engineer office at an early date.

Ohio, Portsmouth—The Peebles Paving Brick Co. is said to be planning for the construction of a boiler plant in connection with the proposed rebuilding of the portion of its local plant, recently destroyed by fire with a loss of close to $100,000, including equipment.

Okla., Altus—The City Council is planning for the installation of additional equipment at the municipal power plant, including engine and auxiliaries.

Okla., Canton — The City Council has authorized the immediate construction of a new waterworks, with power house and pumping station, to cost about $35,000. V. V. Long & Co., Colcord Building, Oklahoma City, Okla., are engineers.

Okla., Elk City—The States Power Co., Enid, Okla., is reported to be planning for the construction of a new power plant in this vicinity.

Ore., North Bend—The Mountain States Power Co., Sandpoint, Idaho, will commence work in the near future on a new steam-operated electric generating plant on local site, to be equipped for a capacity of 6,750 hp., estimated to cost $175,000.

Ore., Portland—Charles E. Rumelin, 395 Thirty-second Street, N., and associates plan for the installation of a pumping plant on the North Fork of Scappoose Creek, for a domestic water supply. Application for permission has been made.

Pa., Philadelphia—The Abbott's Alderney Dairies Co., Thirty-first and Chestnut Sts., has filed plans for the construction of a new cold storage plant at 59-63 Armat Street.

Pa., Philadelphia—The Bureau of Supplies and Accounts, Navy Department, Washington, D. C., will take bids until March 25, for 400 seamless boiler tubes for use at the local navy yard, as specified in Schedule 1960.

Pa., Sharon—The Valley Cities Brick Co., Youngstown, Ohio, plans for the installation of steam and electric power equipment in connection with proposed enlargements in the local plant of the Sharon Brick & Clay Co., recently acquired. David Jenkins is president.

Pa., York—T. L. Tasse, York, has had plans prepared for the erection of a new cold storage plant at 156 North George Street, to cost close to $45,000. Edward Leper, York, is architect.

S. C., Charleston—The Tuxbury Lumber Co. is in the market for several watertube boilers, 250 to 300 hp., each, with auxiliary apparatus.

S. C., Newberry—The Public Works Commission, M. L. Spearman, chairman, will take bids until March 27, for equipment for a water supply system, including a one-story pumping station. Paul H. Norcross, Candler Building, Atlanta, Ga., is engineer.

S. C., Walhalla—George L. Wilson & Son, P. O. Box 175, are planning for the purchase of an ice-manufacturing machine, with daily output of about 10 tons; engine to be either crude oil or gasoline-driven.

Tex., Benbrook—The Southwestern Lime Co., W. T. Waggoner Building, Fort Worth, Tex., recently organized, plans for the installation of an air compressor and other equipment at its local plant. E. T. Springer is secretary and treasurer.

Tenn., Chattanooga — The Chattanooga Battery Box Co., East Twenty-eighth Street, will construct a boiler plant at its proposed two-story manufacturing works, for which foundations will be laid at an early date. L. K. Wert is president.

Tex., Coleman—The West Texas Utility Co., has acquired a site and is considering plans for the erection of a new ice-manufacturing plant. G. W. Fry is general superintendent.

Tex., Floydada—The Common Council plans for the installation of a pumping plant for the proposed municipal sewerage system to cost about $50,000. A special election has been called on March 18, to vote bonds in this amount. Plans will soon be drawn.

Tex., Frisco—The Common Council plans for the installation of electric-operated pumping machinery in connection with a new waterworks system, for which a bond issue of $40,000 has been sold.

Tex., Texas City—The Texas Sugar Refining Co. is building a power house in connection with its new local refinery, consisting of a series of twelve buildings to cost in excess of $750,000, with machinery.

Tex., Waco—The Board of City Commissioners plan for the installation of electric-operated pumping machinery at the proposed sewerage disposal plant, estimated to cost $350,000. V. G. Kerr is city engineer, in charge.

Va., Urbanna — The Common Council plans for the rebuilding of the portion of the municipal electric plant recently damaged by fire. An official estimate of loss has not been announced.

Va., West Point—J. W. Marshall is making inquiries for a mechanical blower, geared type, for high pressure service.

Wash., Bremerton—The Supply Officer, Puget Sound Navy Yard, will receive bids until March 31, for one motor-driven, direct-connected, centrifugal pump, 30 g.p.m. capacity, 50 ft. head, 10 ft. suction, one speed, as per specifications on file.

Wash., Pullman—The Common Council is considering the installation of electric-operated pumping equipment in connection with extensions in the sewerage system, estimated to cost $70,000, for which an ordinance has been passed.

Wash., Seattle — The Northern Pacific Railroad Co. plans for the installation of an ice and refrigerating plant in its new fruit storage building to be erected on King Street, near Occidental Avenue, 80 x 250 ft., estimated to cost $110,000.

W. Va., Parsons—W. C. Bond, Thomas, W. Va., and associates, have acquired the local properties of the Clover Run Lumber Co. Plans are under way for the construction of a new mill and boiler plant.